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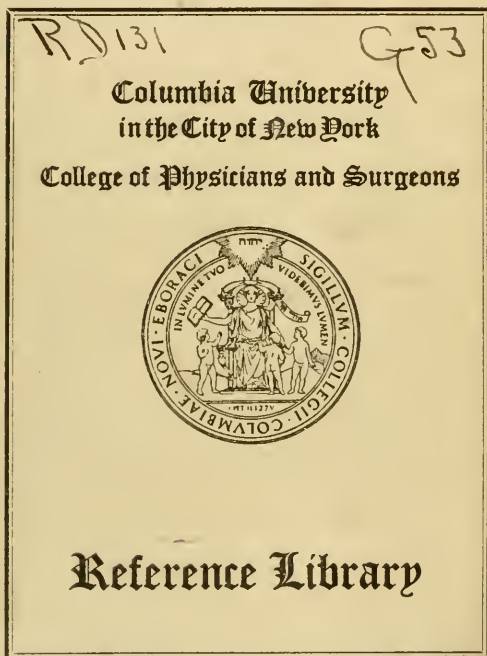
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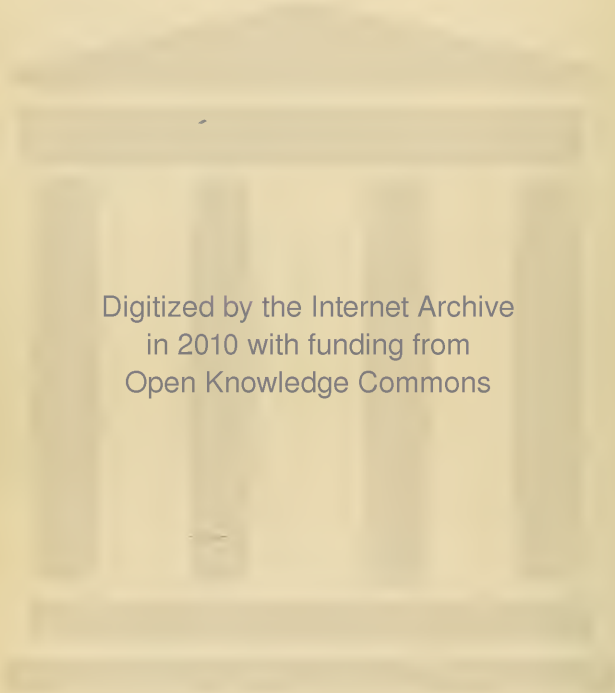
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ATLAS AND EPITOME
OF
DISEASES CAUSED BY ACCIDENTS

BY
DR. ED. GOLEBIEWSKI
OF BERLIN

AUTHORIZED TRANSLATION FROM THE GERMAN, WITH
EDITORIAL NOTES AND ADDITIONS

BY
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RELATIONS TO DISEASES OF THE NERVOUS SYSTEM"

40 COLORED PLATES, AND 143 ILLUSTRATIONS IN BLACK

PHILADELPHIA
W. B. SAUNDERS & COMPANY

1900

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PREFACE.

THE intention in publishing this "Atlas and Epitome" is to present a systematic description of the sequels of injuries caused by accidents. The book is expected to be of interest not only to medical practitioners, but also to students, who, it is hoped, will find it a concise and useful manual supplying a deficiency in medical literature. By reason of its illustrations and the large number of descriptive cases, the work should also prove useful to laymen whose interests are connected with accident-insurance.

The book is divided into two parts, one treating of injuries in general, the other of injuries affecting special structures and regions of the body.

The symptomatology of the sequels of the various forms of injury, as given in the text, date either from the time when the surgeon is usually succeeded by his medical colleague, or from the termination of both medical and surgical treatment, when the patient is ready to resume work or to receive a certificate of disability, as the case may be. The illustrations conform to the same rule.

The symptomatology, therefore, of a large number of the sequels corresponds to the fourteenth week after injury; while in some other cases—the traumatic nervous diseases, for instance—it applies to a much later period.

The date chosen for the illustrations is also variable,

according to the time required for recovery or the ability to resume work.

The colored plates are copied from original water-colors, done for the most part from life, by Mr. Fink, whose work gives evidence of keen perception of medical requirements as well as of artistic merit. The illustrations in black and the pen-and-ink drawings also testify to his ability.

The other illustrations and skiagraphs are from photographs, drawings, sole-imprints, etc., made in my hospital.

The chapters on anatomy are based on original studies on the cadaver as well as on living subjects.

The works of other and better known writers have been freely consulted, with due acknowledgment in the text, whenever appropriate. I refer, among others, to the works of Thiem, Wagner and Stolper, F. König, Helferich, Hoffa, Kaufmann, Rauber, Poirier, Bardeleben, Ferd. Baehr, and F. Riedinger. The text in general is based on an experience with accident-cases extending over thirteen years, and embracing a total of 5245 cases, a considerable number of which have remained under observation since the first few years following the passage of the Accident-insurance Law. Each class of injuries is prefaced by a reference to the number of cases personally observed.

The "Atlas and Epitome" does not claim to cover the subject completely, certain special branches, such as injuries of the eyes, ears, and female generative organs, not being even touched upon. The style is condensed, as is to be expected in a work of this character, but much that is omitted in the text is supplied in the descriptive cases.

The illustrations of certain chapters have had to be curtailed, owing to technical imperfections in the skiagraphs which made them useless for purposes of reproduction. This applies especially to skiagraphs of the pelvis, hip-joint, and spine.

I desire to express my appreciation of the willingness of the publisher to assume the very considerable expense incidental to the preparation of this book.

Its readers will recognize that the work is in many respects imperfect, entering as it does upon a field in which we still have much to learn from experience. I shall be sincerely grateful for any suggestion or advice tending to remedy its faults.

THE AUTHOR.

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INTRODUCTION TO THE AMERICAN EDITION.

THE past few years have witnessed an appreciable increase in the knowledge of diseases induced by physical injury and mental shock. The danger to workmen in special occupations is now known in accurate percentages. The relative value of causes is more firmly established. Symptoms and their significance have been so diligently studied that the outcome of individual diseases can be foretold with remarkable exactness. A variety of causes underlies this advance. Apart from the onward movement of medicine, accidents as causes of disease occupy a place of unprecedented importance. Every year over four thousand persons are killed and over thirty-eight thousand are injured on railways in the United States alone. As shown in the statistics on page 35 of this "Atlas," during the year 1898 over ninety-seven thousand workmen insured under the German law sustained injury. In the nature of things, the quantum of these injuries is taken to the courts for determination. There we find the subject has attained the same prominence that it has in medicine. Court calendars are everywhere crowded with personal injury cases, and negligence law now has reports of its own. It is estimated that one-half the jury trials in the State of New York concern actions for personal injuries. But even judicial records fail to reflect the real activity in this branch of law, since for one litigated claim there are at least eight claims settled out of court.

So far as the writer is aware, Germany, by the passage of the law insuring workmen against injury, is the only country which has attempted to deal comprehensively with the problems involved. An epitome of this law is as follows :

Workmen and employees, with the exception of those of commercial, of domestic, and of a few other callings, whose annual wages do not exceed 2000 marks, are insured against accidents incident to their various occupations. Such persons, injured during their work, are entitled to free medical treatment, and, from the fourteenth week after the accident, to an indemnity of two-thirds of their wages, payable monthly. This applies only to accidents occurring at the time of working ; it does not include industrial diseases. But all preexisting diseases which are brought into activity or whose course is hastened by such an accident must be indemnified under the law. In case of the death of the workman, the widow is entitled to burial expenses, and to full indemnity for herself and her children until the latter attain the age of fifteen years. The insurance to the employees is given and the indemnity paid by the "*Berufsgenossenschaft*"—that is, by an association of the employers of the various trades. The establishment of the amount of indemnity is usually based upon a medical certificate and fixed by the *Berufsgenossenschaft*. The injured workman may appeal from this.

If, after settlement, an important change in the injured person's condition takes place, the indemnity may be re-adjusted, either to the advantage of the workman or to that of the employers.

The amount of indemnity is graded in accordance with the disability. In cases of total disability the full amount is paid ; when the disability is partial, only a part of the amount. If the workman is disabled for his special occupation, but can support himself, though not so well, at

some other, payment is made in proportion to his lessened earning capacity.

The following table shows approximately the proportionate indemnity values in various injuries :

Severe head injuries, with concussion of the brain	50 % to 100 %
Epilepsy	50 % to 100 %
Slight head injuries which cause headaches and dizziness	30 % to 35 %
Loss of one eye	25 % to 33 $\frac{1}{3}$ %
" both eyes	100 %
" an eye when the other eye was already blind	100 %
Deafness in one ear with partial deafness in the other (dynamite explosion)	40 %
Crushing of chest with fracture of ribs, involving diaphragm and lungs	60 % to 75 %
Rupture ; one side, 10 % ; both sides, 15 % .	
All ruptures preventing use of the abdominal muscles	50 %
Paralysis of the extremities following fracture of the spine. The allowance varies with degree of disability.	
Paralysis of one leg	70 %
Pain in the back, diminishing working capacity	20 %
Loss of all fingers and toes	100 %
Loss of right forearm or upper arm	75 % to 80 %
Loss of left forearm or upper arm	66 $\frac{2}{3}$ % to 70 %
" a great toe	10 %
" all the toes of one foot	20 %
" one foot	35 % to 50 %
All affections of the lower extremities necessitating the use of a crutch or a cane	50 % to 75 %

This law insuring workmen against injury was originally passed in 1884 ; since then it has received various revisions and extensions. It lays on physicians generally the obligation to be familiar with traumatic cases, and it has proved to be a great stimulus to the study of this branch of medicine in Germany. And while the German working-man has derived much benefit from its wise provisions, German medicine has also profited by the

means it offers for the observation of how the human body reacts to various kinds of injuries.

The salient difference in the systems as applied in Germany and in this country is that the damages under the German law are determined by an harmonious principle applied whether the employer or the employee is negligent. Under the German method every factor except the extent of the injury is fixed and uniform. In the United States nothing is fixed except the abstract principles of law as set forth in the judge's charge to the jury. A hysteric girl, without responsibilities and without the capacity for self-support, may receive a verdict for some trivial mishap very much in excess of that given a working-man for injuries which disable him for life.

One of the wisest provisions of the German law is that the insurance allowance may be diminished or increased according as the injured person gets better or worse with time. It insures justice to both workman and employer, and practically does away with the question of exaggeration. In America, when the plaintiff gets his money his case is judicially at an end. His disease may become worse, but he is entitled to no further indemnity; or his condition may improve without his being called upon to make any return of the proceeds. Yet the verdicts are notoriously capricious, often unjustly reflecting the sex and personality of the injured.

The contingent fee system, so far as workmen are concerned, is avoided by the German law. It is a system that tends to make the lawyer rather more than an advocate, and the physician rather more than an expert. These sometimes so far exceed the limits of their respective callings as to become partners with the litigant, whose poverty is the real cause of the system. It is but a step further to the "runners" and the merciless pursuit of injured persons who may have claims for damages to bring. The adoption in America of some such plan as the one that Germany has found feasible for the past six-

teen years would unquestionably be mutually beneficial to both employers and employees. The middleman, it is true, would suffer, for the money which now goes to him would remain with the companies or would go to the maintenance of disabled wage-earners.

Important as this question is in its sociologic and legal connections, its true inwardness, so far as the medical man is concerned, is in the added requirements that the prominence of traumatism in general pathology lays upon him. Now, as never before, it is imperative that every practitioner be familiar with the effects of injury on the body in health and in disease.

To express the branch of medical science which has to do with this relationship, the Germans, with their usual fertility of nomenclature, have created the term "*Unfallheilkunde*." *Unfallheilkunde* is not, of course, a distinct branch, such as surgery or ophthalmology. It is in one sense broader than any one branch, as it embraces them all; and it deals with all from the common standpoint of injury as a cause. In this respect it can justly claim a place among the departments of medicine with distinctive characteristics. For example, in traumatic cases causes, both predisposing and exciting, demand special consideration. The first may have been acquired, or may have been transmitted through generations as mental or physical defects. Bodily infirmities, impairment of one or more of the special senses, mental deficiencies, diseases such as epilepsy or general paresis,—in short, anything and everything that renders the individual more exposed to injury or less capable of taking care of himself,—must be reckoned among the predisposing causes of traumatic diseases.

Familiarity with exciting causes falls within the province of special workers. We turn naturally to the railway surgeon for detailed information as to the physical effects of railway injuries, to the ophthalmologist for an intimate knowledge of traumatic lesions of the eye, and to

the neurologist for an explanation of the peculiar disorders of recent date, known as the traumatic neuroses, which so frequently result from the combined influence of physical injury and nervous shock.

It must not be forgotten that the relationship between traumatisms and disorders that are not immediately surgical is often very obscure and difficult of demonstration. In many cases the relationship is incontestable, though how it is brought about is uncertain; in others it can hardly be said, from our present knowledge, to be more than probable. This is especially the case when there is a long time-interval between the receipt of the injury and the first appearance of symptoms.

Diagnosis in traumatic cases means much more than a simple recognition of the particular injury or disease that has an accident as its starting-point. It means the type of man affected by it quite as much as the injury itself, for what in one individual would be little more than an inconvenience would in another be a cause of death. Diagnosis, therefore, implies an estimation of the resistance of the individual quite as much as of the extent of immediate injury; and the ability to estimate resistance implies not only a knowledge of general physiology, but also a familiarity with the social, familiar, and personal conditions that favor or discourage the processes of recuperation and repair. It is the physician who considers the problem before him from this point of view who will most often find his prognosis verified by subsequent events.

The question of simulation naturally comes up under diagnosis. It is one with which the surgeon has little to do. A man can not simulate a broken leg, and self-inflicted disfigurements and mutilations, while occasionally heard of in armies and prisons, are rarely, if ever, attempted in personal injury claims. In the obscurer internal diseases, and especially in those affecting the nervous system, simulation may be, and sometimes is, successfully carried out; but even in nervous diseases the

subject has received more prominence than it deserves. Nearly all American and European writers agree that the creation of symptoms for the purpose of making money out of them is rarely met with. Golebiewski estimates simulation in German workmen at two per cent. Much has been written on the means of detecting simulation. It may be summed up in this : a definite organic type of disease,—such as paralysis,—to be feigned in a way to deceive a physician who is careful, skilful, and reasonably resourceful, is practically impossible. On the other hand, there are diseases, such as epilepsy or neurasthenia, the existence of which can not be denied because the examination of the patient is negative. In such cases, if the patient's story as to his symptoms is to be disproved, he must be kept under constant observation. In the United States such a course is always difficult and often impossible.

The exaggeration of symptoms actually present is a much more important consideration in accident-cases than simulation. It is found especially in functional nervous diseases. No rules for the estimation of the degree of exaggeration in any given case are possible ; but the experienced physician is usually able to tell with a fair degree of accuracy how far symptoms are magnified, and how far the magnification is voluntary or unconscious, depending upon the personal peculiarity of the patient.

The medicolegal relations of diseases caused by accidents form the most important department of "*Unfall-heilkunde*." They are the sum of all the considerations previously mentioned, plus their position in law. In establishing them, account must be taken of the individual's previous earning capacity ; of his predisposition ; of the suffering through which he has gone, as well as that which is still in store for him ; of his actual incapacity, and the probability of its increasing, remaining stationary, or becoming less. These and many other questions must be considered from a purely medical point of view, for it

lies beyond our province to enter into legal questions, although every physician who has to do with traumatic cases would profit by a knowledge of law.

Enough has been said to show the importance and difficulties of the study of these cases. The life of a science, as of a people, is quickly mirrored in its literature, and medical literature has not failed to respond to the demand for collated and progressive information concerning traumatic diseases. The response has taken the form of various periodicals and numberless monographs, but the present book is the first to attempt a treatment of the whole subject.

In the "Atlas and Epitome of Diseases Caused by Accidents" Dr. Golebiewski has given, in brief and succinct form, the present knowledge of this important branch of medicine. As is shown by the number and variety of illustrative cases, his statements are based on an extensive personal experience, and the text embodies a comprehensive review of the literature. He treats the subject chiefly from the point of view of ultimate results, and has made an invaluable collection of facts to show the degree of functional disability that may be expected from a given injury. No department of medicine could adapt itself better to illustration, and the illustrations in the "Atlas" have been chosen with discrimination and executed with skill. The collection of skiagraphs is particularly valuable. It is a great pleasure to be afforded this opportunity of introducing the book to the English-speaking public. It is a reliable and graphic presentation. To the general practitioner it should serve as a ready book of information and reference, and to the specialist, in addition to furnishing facts outside his immediate sphere, it should suggest new lines of inquiry.

It should also have a wide field of usefulness in the legal profession. The anatomic and physiologic summaries at the beginning of the various sections, together with the illustrations, should make the text intelligible to

nonmedical readers ; and a book with these qualifications, on this subject, will certainly be welcomed by lawyers.

In preparing the American edition I have taken the liberty of omitting part of the German text and some of the cases, and of adding a few notes. For nearly all of the translation I am indebted to Dr. Marion McD. Grady.

PEARCE BAILEY.

NEW YORK, *June, 1900.*

PART I.

I. GENERAL CONSIDERATIONS.

1. THE CAUSES OF ACCIDENTS.

THE determining causes of accidents may be conveniently divided into internal and external. The **internal** causes are to be sought in the individuality and condition of health of the victim. To this category belong : (1) Carelessness, recklessness, failure to observe danger notices, inappropriate and clumsy movements, etc. (2) General ill health. (3) Acute and chronic diseases and infirmities.

1. Accidents caused by carelessness and recklessness need not be considered here ; but the injuries to healthy persons brought about through inappropriate and clumsy or forced movements deserve mention. It will be sufficient to enumerate the following : Fractures occurring in aged people from very trivial causes ; fractures of the patella caused by overflexion of the knee-joint, the tension on the ligament pulling away a portion of the bone ; fractures of the olecranon process caused by violent over-extension of the arm.

2. General ill health impairs the soundness and power of resistance of the body, a fact which becomes still more evident in—

3. Acute diseases. With these must be classed acute alcoholic intoxication, which, as is well known, is responsible for many casualties.

Chronic diseases may lead to various accidents, often of a very serious nature, causing permanent impairment

of health or even death. The most insignificant causes sometimes suffice to produce a severe physical injury, to aggravate a preexisting disease, or to call a latent malady into activity. As examples of such disproportion between cause and effect we may instance the fractures that occur in locomotor ataxia, syphilis, tuberculosis, sarcomatosis, etc.; also the hemorrhages from the lungs and the development of pulmonary tuberculosis consequent upon lifting comparatively light weights. Chronic alcoholism also acts as a predisposing cause of injuries. The diminished soundness and power of resistance of the body in chronic diseases furnishes a sufficient explanation of the frequent occurrence of accidents in these cases.

The **external** causes of accidents may be (1) general or (2) special.

1. The general causes comprise: (*a*) Influences of weather; (*b*) influences of season; (*c*) various causes of accidents that are not considered to be accidents of a trade or profession according to the provisions of the Accident Insurance Law.

Under *a* we place the unfavorable influences of rain, snow, frost, long-continued cold, excessive heat, storms, and severe thunder-storms, through which the danger of accidents is heightened.

Under *b* we consider the various influences of the seasons, of holidays and festivals, and of special days of the week: as, for instance, Monday in respect to the building trade ("blue Monday").

(*c*) This third division of the general causes of accidents is made up of a variety of special causes which comprise class 2. The distinction is made chiefly with reference to the matter of insurance, which is collectable only when the individual is injured during the actual performance of the duties of his calling.

2. Special Causes of Accidents.—This class, as already indicated, includes all the causes of accidents occurring as incidental to trades and professions.

2. ACCIDENTS.

Accidents vary according to the nature of the work performed by the injured person. Each trade has its characteristic set of injuries. The accidents to which miners are subject, for instance, are of a different type from those met with in weavers; while carpenters and clothing makers suffer from accidents equally dissimilar in character. The German State Insurance Bureau has published a table of accidents for statistical purposes for the use of all the trades-unions. We quote the most important headings :

Accidents connected with—

Motors.

Elevators, cranes, and derricks.

Steam boilers, steam pipes, and steam cooking apparatus; explosions and explosives (explosions of powder and dynamite).

Inflammable, hot, and caustic materials, gases, and fumes.

Collapse of buildings, etc., blows from falling objects.

Falls from ladders, stairs, etc.; falls into openings or excavations.

Loading and unloading of hods.

Vehicles (being run over by wagons and carts of any sort).

Railroads (being run over).

Shipping and transportation by water (falling overboard).

Animals (kicks, bites, blows), including all riding accidents.

Tools, including simple tools (hammer, axe, spade, hoe).

To the special causes belong also the accidents that occur as the result of overexertion while at work.

3. STATISTICS OF ACCIDENTS.

In 1898, 6,042,618 individuals were insured in 65 industrial trades-unions. Of this number 41,746 suffered accidents: 38,788 were men, 1,572 women, 1,209 boys, and 177 girls under sixteen years. The proportion is, therefore, 6.91 accidents to every 1000 people insured. In the agricultural trades-unions, 11,189,071 were insured; of these, 45,433 suffered accidents—or 4.06 to the 1000. If the industrial and agricultural trades-unions are considered together, the proportion is 5.06 accident-cases to the 1000 insured.

The frequency of accidents in the different ages and sexes is stated in the statistics published in 1893 by the State Insurance Bureau. According to these statistics, 2.73 % of the accident-cases concern children under sixteen years; 8.74 % were between sixteen and twenty years of age, while 88.53 % were over twenty years of age.

The causes of the accidents affecting children under sixteen years were chiefly awkwardness and carelessness, etc. (23.85 %), dan-

gerous work (19.04%), a lack of arrangements for protection (16.74%), and disobedience to rules, etc. (10.55%). The causes at work in the cases between sixteen and twenty years were dangerous work (30.30%), awkwardness and carelessness, etc. (18.84%), a lack of arrangements for protection (13.04%), and disobedience to rules, etc. (9.67%). The causes acting in the cases over twenty years of age were dangerous work (45.46%), awkwardness and carelessness (16.03%), a lack of arrangements for protection (10.22%), defective machinery, etc., (7.14%).

The causes of the accidents among the male workers were chiefly dangerous work (44.36%), awkwardness, carelessness, etc. (16.49%), a lack of arrangements for protection (10.50%). Among the female cases the causes were dangerous work (18.92%), disobedience to rules, etc. (18.60%), awkwardness and carelessness, etc. (16.64%), and a lack of arrangements for protection (14.19%).

The percentage of accidents due to dangerous work shows that the work of male employees is much more dangerous in character than that of female employees. The decidedly high figures of the causes involving a fault on the part of the employee, especially in relation to disobedience to rules, bring us to the conclusion, however, that female workers pay less attention to rules than male workers. The percentage of accidents due to awkwardness, carelessness, etc., is, on the other hand, about equal for the two sexes, showing that female workers are not more deficient in caution and skill than male workers.

Fatal accidents were caused in a large proportion (44.15%) of the cases by dangerous work: awkwardness and carelessness, etc., were the causes in 9.98% of the cases; deficient machinery, etc., in 8.23% of the cases; a lack of arrangements for protection in 7.44%, and disobedience to rules in 6.66%.

The influence of the seasons is important, especially in relation to those who work out of doors, among whom the percentage of accidents is highest in the winter months. More accidents occur in the winter months than in the summer; in fact, in the majority of the trades and industries. The fact that the building trades and the inland shipping trades show a low percentage of accidents in the winter is explained by the decrease in the activity of these trades at that season. The relative percentage of accidents in all classes of out-of-door workers is higher in the winter season, and the cases are, on the average, more serious than those that occur in the summer.

Certain days of the week also have an influence on the occurrence of accidents in a number of industries. Accidents are apt to occur on Mondays in the building trade and among drivers; and on Saturday afternoon in the weaving trade. We must, however, not accept these figures with reservation. Many accidents among drivers which happen on Saturday night or on Sunday are not reported until Monday. The publication of the State Insurance Bureau does not discuss the causes underlying the increased number of accidents occurring on Monday. We are, nevertheless, justified in assuming that the fatigue due to Sunday's pleasures, especially to excessive drinking, is the chief cause.

The time of day often has an influence of no small importance in the causation of accidents; the latter are apt to occur late in the day, when the worker is fatigued. Fatigue must not, however, be looked upon as the chief exciting cause of accidents. It is wisest to avoid generalizations as to this point, and to examine the conditions obtaining in the various industries. We will find that accidents are influenced in their occurrence by definite conditions often dependent upon the peculiar nature of a certain trade: under one set of conditions most accidents occur in the morning, while under another set they are most frequently observed in the afternoon.

4. FATAL CASES.

According to the statistics of the State Insurance Bureau there were, in the ten years between 1886 and 1896, 59,750 fatal cases of accident among a total of 516,762 accidents—or 0.38%. These figures cover all trades-union insurance, but not outside insurance companies.

In the years between 1886 and 1895 fatal accidents among the industrial trades-unions occurred in the proportion of 0.77 to 1000 members insured.

The following table shows the comparative frequency of fatal accidents among industrial and agricultural workers:

<i>Form of Accident.</i>	<i>Industrial Trades- unions.</i>	<i>Agricultural Trades-unions.</i>
1. Burns, scalds, action of caustics . . .	1.34%	0.05%
2. Wounds, contusions, fractures, etc.:		
(a) of arms and hands	0.63 "	0.43 "
(b) of legs and feet	1.19 "	0.94 "
(c) of head and neck	4.33 "	2.94 "
(d) of trunk	3.25 "	3.85 "
(e) of several parts of body together	2.38 "	3.85 "
(f) of whole body	16.78 "	10.02 "
3. Suffocation	0.71 "	0.20 "
4. Drowning	0.92 "	0.24 "
5. Freezing and various causes	0.10 "	0.10 "
6. Stroke of lightning		0.31 "
7. Sunstroke		0.31 "

5. GENERAL CONSIDERATIONS REGARDING TRAUMATISM AND TRAUMATIC DISORDERS.

The effects of traumatism on the human organism may be manifested either by local or general symptoms. In the former case external signs of injury are almost always evident; there may be severe general symptoms, on the

other hand, without visible bodily injury, or local and general symptoms may be observed simultaneously.

The occurrence of purely general symptoms after traumatism is strikingly illustrated by the serious condition described under the name of shock. A discussion of its symptomatology would be out of place here. We should bear in mind, however, that shock may follow all forms of local traumatism, including operations, or be caused by general traumatism—as, for instance, concussions received in railroad accidents. It may even be brought on by fright alone (psychic shock).

General symptoms predominate also in cases of heat-prostration and sunstroke. While the general symptoms of a person suffering from the effects of a stroke of lightning are usually severe, characteristic local signs are not lacking.

The local symptoms of traumatism vary according to the part of the body affected. Personal equation must also be considered. Analogous injuries produced under precisely similar conditions may differ widely in their effects on two different individuals.

II. GENERAL CONSIDERATIONS REGARDING PHYSICAL INJURIES.

I. INJURIES AND TRAUMATIC DISEASES OF THE SKIN.

Contusions ¹ of the skin consequent upon kicks, blows, or falls usually heal in a short time without serious sequels. The same is true of light cases of crushing of the skin.¹ Rapid absorption of the blood extravasations,

¹ A distinction is made throughout this book between contusions and the crushing of a part. By contusion is meant the injury caused by a fall, blow, or kick; and by crushing, the effects of two or more opposing forces bearing on the part, as illustrated by cases of individuals caught between moving objects or under a falling wall or embankment.

whether large or small, is induced by massage. In serious cases of crushing, on the other hand, the process of healing is apt to be a slow one.

A break in the continuity of the skin results in the formation of a **wound**, and as wounds play a highly important part in the history of accident-cases, we are justified in discussing their different forms and origin in this place.

Incised wounds may be caused by sharp instruments or by sharp materials of trade, such as glass, tin, slate, pointed stones, etc. The prognosis is better in the former instances than in the latter, since there is always danger of foreign bodies remaining in the wounds that are produced by the materials of trade. Wounds caused by machines, such as circular saws and the like, are, on the other hand, often of a very serious nature, resulting in the mutilation or loss of several fingers or phalanges. Total disability for self-support is very apt to be the result in such cases.

Severe **incised wounds** caused by blows of a hatchet, ax, or scythe often reach so deep as to injure the bone, and are apt to leave scars which interfere with the functional action of the part.

The **punctured wounds** which we need to consider are those caused by sharp-pointed instruments or materials of trade, such as chisels and iron wire, respectively.

Lacerated wounds are especially serious, because of their liability to infection, and because the ragged edges of the wounds are a common form of injury in the building and slate-roofing trades and in those concerned in the manufacture of wooden articles; they are caused by protruding nails, sharp edges of slate, splinters, etc. Indirectly, they may be caused by overtension of the skin, when this is atrophic or cicatricial—on the extensor surface of the knee-joint, for instance. Occasionally, this accident may occur when the skin is normal, as described recently by J. Riedinger.

Wounds caused by **crushing** of the parts are also slow

to heal, either because of the ragged edges of the wound or in consequence of the entrance of infectious material at the time of the injury. As a rule, the skin does not suffer alone; the deeper structures, even the bone, are very frequently involved, and are always so in severe cases, as when the individual is struck by falling beams, iron plates, granite blocks, or is caught between cog-wheels. It is hardly necessary to state that the infectious bacteria find an easy entrance into wounds of this kind.

Bullet-wounds play but little part in the subject with which we are here concerned. Wounds produced by explosions—by blasting in mines and quarries—are, on the other hand, often met with. Foreign substances are likely to be carried into the tissues, adding a further element of danger to that attaching to any open wound.

The insignificant origin of the majority of **infected wounds**, and the great danger of permanent impairment or loss of functional power which they entail, make a clear understanding of the subject of importance to us.

Infected wounds necessitate a longer course of treatment than noninfected wounds, and their prognosis is always less favorable. Sometimes the process of healing is very protracted.

In the great majority of cases the infectious process begins in a trifling wound of a finger, caused by a prick, a scratch, or the entrance of a splinter. The lower extremity is seldom affected. The wound does not bleed, and is often scarcely discernible. The anatomy of the skin furnishes the explanation of the serious consequences of such an injury: if the wound reaches the Malpighian layer of the epidermis, the door is opened to the entrance of infection. The injury being so slight, it does not occur to a workman to put down his work. If he feels uneasy and speaks to his employer about it, he is likely to be told not to stop work for such a trifle. So the splinter, for example, is removed by the workman himself, who then ties a dirty rag around his finger and resumes work. Three

days later fever, with pain and swelling of the part, usually begins; the pain rapidly increases and soon runs from the finger up the hand and arm to the axilla; the whole hand is red and swollen, and hot and resistant to the touch. We have to deal, in short, with a phlegmonous inflammation, or, in popular language, with a case of "blood-poisoning." The infectious germs may have entered at the time of the injury, or afterward, through the wound. The incubation period is usually about three days; it may, however, be as short as twenty-four hours, or as long as three weeks.

For the cases not seen by the physician until well developed, a bad prognosis in respect to functional power must almost always be made. Repeated operative procedures on fingers and hands are generally called for, which, as a rule, result in permanent disability of the part. The fingers are usually left quite stiff, while the hand, fingers, and forearm are lined with scars; the skin feels cold, and is often cyanotic (glossy skin).

As already stated, infected wounds are almost always found on the hands. In cases of involvement of the thumb or the little finger the condition is especially serious, for the reason that the tendon-sheaths of both communicate with the common tendon-sheath of the flexors of the fingers. The infected wounds that occasionally occur on the lower extremities are apt to call for very extensive operations, resulting in a growth of cicatricial tissue which impairs the usefulness of the limb, especially when located about the principal joints.

Slight abrasions of the skin of the leg when the latter is the seat of varicose veins quite frequently serve as the starting-point of a suppurative infection, no attention being paid to the injury before the development of the severe pain and fever which accompany the inflammation. While the prognosis as to usefulness of the parts is usually unfavorable, it is rarely so in regard to life, although these cases do occasionally end fatally.

The advisability of obtaining medical advice as soon as possible is seldom so forcibly illustrated as in case of infectious wounds. The earlier treatment is begun, the better are the chances for a favorable course and recovery of functional power.

Wounds may be caused by the action of caustics—by strong solutions of carbolic acid for example; they may become inflamed from the use of such antiseptics as lysol, creolin, and iodoform. Poisoned wounds may, moreover, be caused by the bites of leeches, snakes, or mad dogs.

A review of the methods of **treatment of wounds** belongs to the realm of surgery. One point will bear emphasis here, however,—namely, the necessity of paying careful attention to the edges of the wound, with the view to securing as slight a scar as possible. The vital importance of treating wounds on aseptic principles and, if necessary, antiseptically, is, of course, recognized by all who are in accord with modern scientific teaching. It must be added that aseptic methods, however desirable in themselves, are not adapted for home treatment, since the conditions necessary to their success are to be found only in a hospital.

Every wound leaves a cicatrix, the size of which varies with the amount of tissue lost. Wounds that heal by first intention may leave such small cicatrices that they are hardly discernible later on, and may disappear altogether. A cicatrix may be but the depth of the skin, or it may extend into the tissues underneath (cicatrix atrophica), or protrude above the skin (cicatrix hypertrophica). It may be movable with the skin or be attached to the underlying structures, even to the bone itself. Newly formed cicatrices are more or less red in color, but in time they grow paler than the surrounding tissue. While they are often very sensitive at first, old cicatrices, especially if extensive, are generally below the normal in sensibility. They may, on the other hand, be exceedingly hyperesthetic and subject to neuralgic pains. In such

cases a slight touch sometimes reflexly calls forth powerful clonic contractions, which are undoubtedly due to irritation of nerve-fibers caught in the scar during healing. The appearance of a cicatrix and its influence on the functional activity of the part depend upon its situation. Cicatrices on the legs remain hyperemic longer than when situated on the trunk, and are often pigmented in addition. In some individuals hypertrophic cicatrices develop into peculiar nodular growths called scar-keloids, which frequently grow rapidly, and are apt to return after removal. (See Plate 21.) All cicatrices have a tendency toward retraction; this is most marked in cases of deep and extensive burns. The cicatrix, by pulling the skin from all sides, gives it a ray-like appearance. If the cicatrix passes over a joint, motion in the latter is impeded, especially in cases of deeply attached scars or scar-keloids. The joint may, as a result, become completely ankylosed, and be set at an angle. Cicatricial tissue overlying a joint is likely to be overstretched by unguarded movements, and in consequence to crack and become sore. It also displays great sensitiveness to cold in this situation. Much suffering may arise from involvement of nerve-branches in the scar, while similar pressure on the vessels interferes with the circulation.

Therapeutic measures are calculated only to neutralize or diminish the harmful effects of cicatrices. The latter may be prevented from cracking by inunction with some pure fat, by the use of a suitable protective bandage, and, more particularly, by limiting the movement of the joint. In case of impaired mobility of a joint the difficulty can be gradually overcome by massage and systematic exercise on a medicomechanical apparatus, with a view to stretching the cicatrix. If the attachments of the cicatrix are not too broad and deep, it may gradually be loosened by means of massage, leading in favorable cases to a regeneration of the connective tissue of the whole scar, which is very deficient in fat and in connective-tissue cells.

Electricity is also of service, especially in the induction of hyperemia by direct application of the galvanic current. Operative interference is indicated when severe pain is caused by pressure on the nerves in the scar. Plastic operations are often advisable, but the effect of the new scar on the action of the part should always be carefully considered before undertaking any operation on cicatrices, as it may prove more disadvantageous than the offending scar itself. Cicatrices which at first are bound down to the underlying tissues are not infrequently loosened in the course of time, as a result of the unaided efforts of nature.

The treatment of *burns* is too well understood to need discussion here. Of the cicatrices caused by burns only those produced by burns of the third degree call for mention here. Cicatrices due to burns of the second degree are usually quite superficial and movable, and they do not at all interfere with the functional activity of the part. Burns of the third degree, on the other hand, often leave scars that are hard and resistant to the touch, firmly bound down, and quite immovable. Such scars greatly impede the circulation, and when situated around the joints, interfere with their action even to the extent of causing complete ankylosis. This is most frequently the case when the wrist or ankle is involved. The cicatrices are often distinguished by a marked and persistent hyperesthesia. The treatment is that of cicatrices in general.

Abrasions and similar trivial injuries of a leg affected with varicose veins deserve brief mention. As a rule, such injuries receive no attention until ulceration takes place, either for the first time or at the site of a former ulcer. If possible, varicose ulcers should be treated by zinc salve bandages, and the patient be allowed to work. The bandages should, at any rate, be given a trial in all appropriate cases. It is advisable at the same time to prohibit the patient from doing heavy work that necessitates his standing, or from carrying heavy loads. In

severe cases rest in bed is indicated, and preferably hospital treatment.

Frost-bites do not call for special discussion here. The cicatrices which result in severe cases are to be treated as usual.

The *changes in the skin* caused by gangrene are to be judged from the same standpoint as burns, frost-bites, and their scars.

Anemia of the skin of the face and whole body, not to be confounded with the peculiar pallor normal to some individuals, is often seen in patients who have passed through a serious illness, or have been confined to a sick-room for a long time. Local anemia occurs very frequently as a symptom of atrophy. The anemia is often preceded for a considerable period by a hyperemia, especially in case of impeded circulation of the lower extremities following crushing or fracture. The condition is distinguished by bluish-red swellings (hyperemias of congestion). The temperature of the part may be raised or distinctly lowered. Profuse perspiration occurs in some cases. The lividity of the skin may even amount to complete cyanosis.

Therapeutically, great benefit can be derived from warm baths, either local or general, steam baths, massage, medico-mechanical exercises, and electricity. When the disturbances previously mentioned are consequent upon a fracture, they usually begin to diminish as soon as complete union is established.

Cicatrices and trophoneuroses always cause an atrophy of the skin. It grows thin and dry, poor in cells, fat, and blood-vessels, and tends to crack and to form gangrenous ulcers, especially on exposure to cold. After nerve-injuries it is cyanotic and cold to the touch (glossy skin). The patient, too, generally complains of feeling cold and often, even in summer, wears a flannel bandage or a warm glove around the part.

The chief object of treatment is the removal of the

cause. This may, however, be precluded by the nature of the injury, and in such cases temporary relief is all that can be hoped for.

We are sometimes called upon to decide whether *elephantiasis* of the lower extremities is a result of traumatism. This disturbance will be dealt with in the second part of the book.

Erysipelas is an infectious disease of the skin which may indirectly be due to traumatism, since a very insignificant wound can afford entrance to the germs of the disease. It often causes severe general disturbances, for which the accident is also to be held indirectly responsible.

Tuberculosis of the skin may also be caused by traumatism, indirectly if not directly. Direct infection occurs when the tubercle bacilli enter the body through a wound. Thiem mentions four forms of this disease following injuries: (1) The ulcerative form; (2) the warty form, affecting the external layer of the skin; (3) lupus; (4) scrofuloderma.

2. INJURIES AND TRAUMATIC DISEASES OF THE NAILS.

Crushing of the distal phalanx, with or without fracture, is followed by an inflammation of the nail-bed, often purulent in character, as a result of which the nail is cast off. The new nail is usually misshapen, and sometimes so atrophic that it is no harder than the horny layer of the skin, and merges into the latter at the base and sides. Irregular hypertrophic processes sometimes develop in the middle of such a nail, and grow quite rapidly, necessitating constant trimming, especially if one of the toenails is involved. In the latter case, without such trimming the wearing of a boot is impossible.

Atrophy of the nail may also follow an injury to the nerves supplying the distal phalanges of the fingers and toes.

Other disturbances caused by injuries to the nail will be discussed in Part II of this book.

3. INJURIES AND TRAUMATIC DISEASES OF MUSCLES AND TENDONS.

Contusions of muscles due to blows, falls, or kicks usually heal quickly, without serious sequels. Blood extravasations are soon absorbed, especially when massage is employed. If a myositis develops, wet compresses at first (Priessnitz), with weak galvanism and like measures later on, will be found helpful.

Sometimes the nerve supplying the muscle is injured as well, and neuritis or paralysis develops in consequence.

In cases of severe crushing, both muscle-substance and skin are apt to be badly torn, and, as foreign bodies are frequently carried into the tissues, purulent inflammation often follows. When healing finally takes place, the muscle is left shrunken and partly replaced by cicatricial tissue which causes, in time, a contraction of the muscle and in certain cases a contracture of the whole limb. Massage, local steam baths, and medicomechanical exercises will act favorably on the cicatrices and the disturbances to which they give rise, even though a complete cure can not be effected. In some cases, however, all treatment fails to relieve the condition.

The complications which we need to consider are lacerations of the skin and other soft parts and fractures of the bones. The muscles may be lacerated or pierced by fractured bones. A discussion, however, of these injuries will not be entered upon at this time. When the skin is also pierced, a hernia of the muscle may result, but this may cause no functional disturbance. Partial lacerations due to falls, kicks, and similar accidents can not be distinguished from the contusions and crushings already mentioned—the diagnosis of muscle-laceration often serves for either of the other conditions.

The phrase "muscle strain" denotes slight lacerations of the muscle-substance caused by indirect violence. The injury may be looked upon as an early stage of serious

subcutaneous ruptures. The latter are most frequently seated in the biceps of the arm, but may occur also in the muscles of the calf, the upper part of the thigh, and the abdomen. The injury is caused by the forced contraction of a muscle while the limb is in violent motion, as in parrying blows, for instance. In consequence of the retraction of the torn ends of the muscle quite a broad gap may be left between them, and often remains as a permanent defect, unless the muscle is repaired by operation. The degree of atrophy of the muscle and the loss of power depend upon the extent of the injury. The point of rupture can most readily be distinguished when the muscle is contracted or put on the stretch. During contraction it appears as a ball-like mass, especially noticeable in the case of the biceps of the arm. Ruptures usually involve only a part of the muscles, complete ruptures being very rarely observed. The muscle proper is not always concerned in the injury: sometimes it is the tendon that is ruptured, or a bit of bone is torn off at the point of attachment; occasionally, the muscle or tendon suffers partial rupture at the same time.

The inflammations that attack muscles after crushing have already been referred to. Even slight injuries often give rise to severe suppurative processes, necessitating repeated operations, as a result of which an extensive growth of cicatricial tissue takes place with the usual sequels of atrophy and disturbances of temperature and circulation. Complete loss of function is the rule in such cases. Paralysis of muscles is equivalent to paralysis of the motor nerves that supply them.

The paralysis may be complete or only partial, and upon this point depends the degree to which the muscle is functionally disabled. A paralyzed muscle loses its tone, and soon undergoes atrophy, which in some cases becomes extreme. In cases of partial paralysis the electric irritability is diminished, and in cases of complete paralysis it is entirely lost (partial or complete reaction of degenera-

tion). Large muscles may be wholly or only in part affected by the paralysis.

Muscles frequently suffer dislocation in consequence of the rotation of the ends of fractured bones or of the dislocation of certain joints. The subject will be considered in the second part of this book.

Muscular Atrophy.

A muscle is an apparatus of movement, having the function of imparting a certain limited motion to that part of the skeleton to which it is attached. The motion is caused by the contraction of the muscle, and such contractions are necessary to its good condition. By regular exercise a muscle is made larger and firmer, as evidenced by acrobats, gymnasts, oarsmen, etc. Disuse has the reverse effect: the muscle loses in size and strength, and becomes soft and flabby. This condition is known as atrophy, or the atrophy of disuse. The opposite condition,—an abnormal increase in size,—arising from constant training, is termed hypertrophy.

The fibers of an atrophic muscle are in a state of degeneration, the nuclei being increased in number.

Atrophy is to be distinguished from atony; the latter denotes a condition of temporary or permanent relaxation. While an atrophic muscle is necessarily also in a state of atony, the reverse does not hold good. Although atony is often a precursor of atrophy, it may be only a sign of temporary fatigue on the part of a healthy muscle. The expression "atrophy of disuse" is not altogether applicable to the condition previously described; it is, indeed, often inappropriately used. The atrophy of disuse, as commonly understood, expresses a wasting of the muscle consequent upon inactivity; the functional power is not lost. It is observed, for instance, in muscles kept inactive because of pain consequent upon motion of an inflamed joint. If, on the other hand, a muscle loses its functional power, as in cases of fracture or paralysis, the atrophy which it

then undergoes, although the consequence of inactivity, differs to a marked degree from that of the other form. It is, perhaps, permissible to speak of the two forms in the order described as the atrophy of voluntary and involuntary disuse, respectively. The prognosis differs considerably for the two forms.

Muscular atrophy can be divided into three forms, with reference to its origin: (1) Myogenous; (2) neurogenous; (3) infectious. (Firgau, "*Arch. f. Unfhkd.*," vol. II, books 2 and 3.)

In the first form the process begins in the muscle itself. As a result of a fracture of a bone to which the muscle is attached, its point of origin and of insertion approach each other; the muscle loses its tone, and subsequently atrophies. Atrophies consequent upon diseases of the joints are also included in this group.

The neurogenous form comprises the atrophies due to injuries and inflammation of the nerve. When the nerve undergoes degeneration, the atrophy is of the degenerative type.

The third form includes the atrophies that follow an infectious process, such as a suppurative inflammation.

Muscular atrophy, as a rule, affects only part of the muscle, complete atrophy being very rarely observed.

In respect to prognosis muscular atrophies are to be divided into curable and incurable.

We must bear in mind, too, that local paralyses and atrophies may be caused by systemic poisoning—as, for instance, by lead, arsenic, or alcohol. This adds a fourth form, of toxic origin.

The **diagnosis** of muscular atrophy is usually simple.

In making an examination the affected part should always be compared with that of the opposite side, both at rest and during contraction. Changes in size and shape of the muscle and in the position of anatomic landmarks are thus clearly brought out. In the case of the lower extremities the landmarks will invariably be found lower

down on the atrophied side. To the touch, an atrophied muscle feels soft and flabby. The electric excitability may be normal, diminished, or completely lost. The skin over the affected muscle is frequently cold, especially in cases of paralysis, and may appear dark red or cyanotic. Functional power is, as a rule, diminished most appreciably as to strength and endurance; we do, however, occasionally see marked cases of atrophy without apparent loss of power. [Fibrillary twitchings are very frequently present in atrophying muscle.—Ed.]

The atrophic process is seldom confined to one muscle, but extends, as a rule, over the whole limb. Thus, atrophy of the extensor muscles is followed by atrophy of the flexors, but the primary process is usually better marked than the secondary. The atrophy may vary in degree even in different parts of the same muscle, as often observed in the deltoid, biceps, etc.

The **prognosis** of muscular atrophy depends, first of all, on the nature of its cause.

The form to which reference has been made as the atrophy of "voluntary" disuse can be cured with relative ease. Massage, electricity, and medicomechanical gymnastics will restore the muscles to their former condition within a few weeks.

Paralyzed muscles require a much longer course of treatment, but are also entirely curable unless the paralysis depends on the division of a nerve, in which case it is permanent.

An absolutely unfavorable prognosis must also be made after extensive suppuration, when the joint is permanently stiffened, or when the tendon is torn from the bone at its point of insertion, as frequently occurs in cases of fracture of the patella or the olecranon process. When a limb is shortened by fracture, the atrophied muscles do not regain their original size and strength, but adapt themselves in these respects to their new requirements.

In regard to the question of **treatment** we must, first

of all, carefully consider the cause of the atrophy and the possibility of its removal. We will then be readily able to judge what, if any, are the chances for improvement. If the outlook is favorable, benefit will certainly be derived from massage, baths, cold douches, electricity, and medicomechanical gymnastics.

4. INJURIES AND TRAUMATIC DISORDERS OF TENDONS AND TENDON-SHEATHS.

The superficial location of most of the tendons renders them very liable to injury. Contusions and, more especially, the crushing of a tendon very frequently lead to an acute tenosynovitis, which is exceedingly painful, but which, if treated at once by rest and compresses, may soon be allayed. If suppuration sets in, however, the process is greatly prolonged, and the prognosis as to restoration of function becomes unfavorable, especially if shreds of the tendon slough off. The removal of a piece of tendon entails permanent loss of functional power. Acute tenosynovitis occurs also as a result of strain. Chronic tenosynovitis is recognizable by crepitus on movement; it is not, as a rule, painful, but leads to contractures which, in turn, cause functional disability, as when the hand, for instance, is involved. It is important to remember that a tendon affected by chronic inflammation has lost its elasticity, and is therefore liable to be ruptured by a strain. Workmen who constantly use their hands in firmly grasping and holding an object often suffer from chronic tenosynovitis of the fingers, with consequent contractures of the latter. The chronic inflammation develops as the sequel of an acute process caused by repeated strains. The associated muscles are always more or less atrophied in these chronic cases.

Incised wounds that completely sever the tendon are of frequent occurrence among certain classes of workmen, such as wood-carvers, carpenters, and others who use circular saws and similar machines. Glaziers and

slate-roofers suffer this injury by falling on glass or slate with the forearm outstretched.

Unless the tendon is sutured, its functional power is permanently lost. If several tendons, those of the forearm, for instance, are severed, it is difficult to suture them in the proper order, and a mistake leads to decided functional disturbance.

Subcutaneous ruptures, which have been referred to in the chapter on muscles, are more apt to involve diseased than healthy tendons. When rupture occurs, or when in addition to rupture the bone is fractured at the point of insertion of the tendon, the muscle at once relaxes, and, unless its tone is restored by operation, it undergoes atrophy. Later on, when the atrophy has become well established, it is too late to expect benefit from any form of treatment.

Tendons may become displaced, most frequently those of the long head of the biceps, the peroneus longus, and the tibialis anticus. When the accident causes much inconvenience, it is advisable to fasten the tendon in its normal position—a procedure that gives excellent results. Complete displacement of a tendon deprives it, of course, of all functional power.

Tendons are often dislocated simultaneously with their muscles when their normal relations are disturbed as a result of ill-set fractures or stiffness of a joint. Such dislocations impede the action of the joint with which they are associated.

5. INJURIES AND TRAUMATIC DISEASES OF BURSÆ.

Bursitis is very frequently seen in accident-practice as a consequence of crushing. When the large bursa of the knee is affected, the diagnosis is very plain, but the condition is not so easily recognized in other locations—as, for instance, on the shoulder, hip, hand, or foot. Unless the bursæ communicating with the joints are involved, there is no pain, even during the acute inflammatory

stage, and the patients usually are able to perform their customary duties without inconvenience. When the exudation is absorbed, the membrane remains thickened and dry; crepitus then becomes noticeable, and is sometimes so loud as to be heard at a considerable distance. The usefulness of the bursa is not thereby impaired, however. A muscle whose tendon plays over a large bursa undergoes atrophy during an acute inflammation of the latter, and does not completely recover for some time after the subsidence of the disease. It is a well-known fact that bursitis is very likely to become recurrent.

The affection is frequently observed as the result of constant irritation of certain parts—as, for instance, the shoulder in porters, and the knee in scrub-women. Such irritation sometimes causes the formation of new bursæ.

Bursæ occasionally become displaced. I shall refer in the second part of the book to a case of this kind involving the subcalcaneal bursa.

6. INJURIES AND DISEASES OF FASCIÆ.

When the fascia investing a muscle is torn, the latter presses through the opening and forms a muscle hernia. The injury may be directly caused by crushing or by penetration of the sharp ends of a fractured bone, or it may be due to indirect violence. We see illustrations of the latter mode of origin in hernias of the thigh-muscles in riders, especially cavalrymen, and in those of the calf-muscles in athletes who practise jumping. The hernias appear as small, soft tumors, giving rise to no inconvenience, and never, in my experience, to permanent disability. They are quite often seen in workmen, generally in the lower extremities, and it is often difficult to ascertain how they were caused.

Contracture of the palmar fascia, with consequent contracture of the fingers, follows repeated strains, suppurative inflammations, or traumatism of any kind that gives rise to trophic disturbances. The injury may be local,

such as crushing of the palm of the hand with subsequent neuritis, or may affect the spinal cord, causing degeneration of the ganglion cells of the anterior horns.

The plantar fascia likewise may become irregularly thickened and contracted as the result of direct traumatism, or of injury to related structures—as, for instance, fracture of the *os calcis*. It is to be noted that the toes are not involved in the contractures; the knot-like points of thickening of the fascia, however, interfere with walking.

7. INJURIES AND TRAUMATIC DISORDERS OF LIGAMENTS AND CAPSULES.

Torsion may cause the laceration of the ligaments and capsules of a joint, but, as a rule, the injury is too slight to result in permanent trouble. The ligaments may, on the other hand, be so badly torn as to lead to loose-jointedness, as is frequently observed in the case of the knee-joint. The lacerations caused by dislocations are much more extensive, and are apt, in spite of the most skilful treatment, to lead to contracture and ankylosis.

Other traumatic diseases of these structures to be mentioned are the following: Thickening of the capsule, with hyperplasia of the synovial folds following inflammatory exudation; relaxation of capsule and ligaments, with consequent loose-jointedness, seen in cases of paralysis; cicatricial contractures after lacerations, etc.

8. INJURIES AND TRAUMATIC DISEASES OF THE BLOOD-VESSELS.

The radial and ulnar arteries are those most frequently involved in direct traumatism, since the forearm is particularly exposed to the danger of blows and incised wounds.

Lacerations of arteries caused by fracture and severe crushing are a more serious form of injury, especially in cases when the lower extremities are involved. The

blood extravasations and venous stasis are very extensive, and the edema and cyanosis which follow persist for a long time.

Aneurysms develop either as a result of direct violence to the arteries or of strain. By careful inquiry, we can generally ascertain the true cause of the injury. A patient is always more or less disabled by an aneurysm, the degree to which his working capacity is curtailed depending on the size and location of the aneurysm. In many cases he is incapable of self-support. Heavy work is always to be prohibited.

Arteriosclerosis is a disease to which workmen are especially subject. It can usually be traced to the effects of alcoholism, syphilis, chronic lead-poisoning, gout, and the deprivations of poverty. It may, however, develop as the result of an accident, or its development may be hastened thereby. It is then usually to be looked upon as a symptom of an advanced stage of accident-neurosis, of which tachycardia is an early symptom. In such cases it has a good psychic effect on the patient to make the examination and settle the question of insurance as soon as possible. In addition, all excitement is to be avoided. Many cases thus treated show decided improvement in time.

In arteriosclerosis there is constant danger of rupture of the vessel-walls, which are inelastic and brittle; hence, the patient is always liable to an attack of apoplexy. When the arteriosclerosis is, directly or indirectly, caused by an accident, the apoplexy that results is also, in the eyes of the law, to be attributed to the accident.

Varicose veins are frequently seen in workmen as a result of prolonged standing, or of repeated attacks of constipation. The disease, however, may be hereditary. Unless complicated by phlebitis, eczema, or varicose ulcers, the varicosities may be very large and yet not interfere with work. The affected individual may, on the other hand, suffer great inconvenience and be seriously crippled.

It is a well-known fact that a slight abrasion of the skin of a leg thus affected, especially if neglected, is very apt to lead to the formation of an ulcer which is exceedingly slow to heal and ever ready to recur.

Such injuries as fractures of the leg or thigh, with marked displacement of the broken bones, the growth of large calluses or extensive cicatrices act either as direct causes for the development of varicose veins, or increase a preexisting affection. Shortening of a limb after fracture may also have the latter effect. A limb which is the seat of varicose veins is always increased in size, and may be so highly edematous in consequence of a succession of ulcers or thromboses as to well warrant the use of the term elephantiasis cruris.

It is worthy of note that the bone in cases of marked varicosity, more especially when complicated with recurrent ulcers, is often greatly thickened. In one case of my own, that of a workman about thirty-seven years of age, the fibula was shown by an X-ray photograph to be as large as the tibia, if not larger. Such hypertrophic bones are said to be denser than normal.

9. INJURIES AND TRAUMATIC DISEASES OF THE NERVES.

Slight contusions of the nerves, caused by falls, kicks, or blows, usually give rise to only temporary disturbances of sensation, such as numbness or formication. There may also be paralysis, which, as a rule, passes off in a few days; even when it persists for a long time after a severe injury, it can usually be cured eventually. Sometimes the paralysis is accompanied by symptoms of neuritis, or there may be neuritis without paralysis. For the paralysis, massage, baths, medicomechanical gymnastics, and electricity are to be recommended, and their good effect is usually soon apparent. When the muscles have undergone atrophy, they will invariably be found to need treatment for some time after the paralysis is cured.

Neuritis, during the period of greatest pain, is best treated by a weak galvanic current, or by small sparks from a static machine.

Dislocations or fractures may cause stretching of a nerve, and as a result it is frequently strained and partially torn. The paralysis or neuritis that follows such injuries is always of a more serious nature than in cases of simple contusion. The prognosis is a more favorable one when the bones or joints are set at once. When a nerve is involved in the growth of a callus, it undergoes pressure-atrophy; the muscles which it supplies atrophy rapidly in consequence, and trophoneurotic disturbances soon become apparent. The only hope of cure lies in surgical interference, in releasing the nerve from the callus.

Dislocations of nerves have so far been observed only in the case of the ulnar at the elbow. The paralysis that ensues can be cured by replacing the nerve and suturing it in position. The complete severance of a nerve by a cut or similar injury is necessarily followed by paralysis and trophoneurotic disorders. The median and ulnar nerves in their course down the forearm are those most frequently involved, because most exposed to accidents of the kind. If not promptly sutured, the nerve will degenerate, and the muscles it controls will be completely paralyzed, unless, as happens in rare cases, the cut ends do not retract and become reunited by a growth of nerve-callus.

For the symptoms of trophoneurosis I would refer the reader to the cases and illustrations in the second part of this book. (Plate XXII.) The peripheral end of a severed and completely paralyzed nerve when stimulated by the galvanic current gives the reaction of degeneration.

If the nerve is not completely severed, or if union has taken place by the formation of nerve-callus, we may hope for gradual improvement in the paralysis, although it may not become apparent for a year or two. The power of

voluntary motion may be regained earlier than galvanic or faradic excitability.

Paralyses through nerve-affections are often caused by injuries, a number of which have already been mentioned.

Neuralgia.

By this term is meant a severe attack of pain in one or more nerves, in which no definite pathologic changes can be recognized. Neuralgia has a multiplicity of causes ; we are here specially concerned with those of a traumatic nature. It may follow direct injury to the nerve, or it may be due to some pressure on the nerve, as in case of callus, aneurysm, etc. The pain is usually confined to one nerve and its branches, which can be clearly traced by the tenderness felt on pressure.

Predisposition to neuralgia is an important factor in its development, even when traumatism is the exciting cause. Chronic alcoholism and chronic lead-poisoning are among the predisposing causes. In such cases a slight injury to the hand or foot may give rise to a neuralgia of the whole limb. Accurately speaking, neuralgia is not directly caused by traumatism, but develops, as already indicated, in consequence of a predisposition that only needs special stimulation in order to assert itself ; it must not be confounded with the pain due to the injury itself. Neuralgia may be excited also by neuromata or by diseases of the periosteum or bone.

In treating the affection we must consider the idiosyncrasy of the patient. Some individuals are much benefited by massage, while it does not agree at all with others. Much depends on the skill and judgment of the operator. Galvanism should always be tried, at first using a weak current.

The electric spark of the static machine often gives brilliant results ; also the employment of the static breeze is sometimes useful.

Hot wet compresses, inunctions of chloroform, oil of

hyoseyamus, etc., are sometimes found useful. In some severe cases that had resisted all previous treatment nerve-stretching has been practised with success.

The internal treatment includes the use of quinin, arsenic, salicylate of soda, iodid of potassium, antipyrin, phenacetin, etc.

Mild forms of neuralgia, although causing the patient great discomfort, do not give rise to fever or affect the general health. The appearance of the patient so little accords with his sufferings that simulation may be suspected. In severe cases of long duration, on the other hand, the general health deteriorates very considerably.

It is hardly necessary to mention the difficulty that frequently confronts us of distinguishing between neuralgia and neuritis.

Neuritis.

Neuritis may be directly or indirectly excited by traumatism.

Among the causes frequently observed are the following: Contusions, dislocations and fractures, incised wounds of all kinds, penetration by splinters of glass, etc., caluses, exostoses, or frequently repeated pressure from any source. Neuritis may develop, also, as a result of inflammations in neighboring structures, such as the tendon-sheaths, the periosteum, or the joints; or of inflammations affecting the whole limb or region. It is especially prone to occur in consequence of phlegmonous inflammations.

In respect to the symptomatology of neuritis, which is too well known to need repetition here, it is sufficient to state that acute neuritis often sets in with high fever, and that it is exceedingly painful.

The patient is completely disabled during an acute attack, and may be partly crippled by the chronic form.

It is important to remember that an ascending neuritis, developing after a peripheral injury and progressing upward along the course of the nerve to the nerve-centers, eventually gives rise to symptoms that ordinarily indicate

disease of the latter. The treatment is similar to that given for neuralgia.

Alcoholic neuritis may be directly excited by traumatism, or may be thereby increased in severity. Crushing of the leg or knee involving the peroneal nerve, crushing of the hand, and similar injuries in alcoholic subjects, may cause a local neuritis (of the peroneal nerve, for instance) or a multiple neuritis. Alcoholic neuritis is exceedingly resistant to treatment, and varies in intensity and symptoms in proportion to the quantity of alcohol consumed. The symptoms are as follows: Motor paralysis of the peroneal muscles and the quadriceps extensor, while the patellar reflex is either lost or greatly exaggerated. [In the early stage of multiple neuritis the knee-jerk is sometimes hypertypical. This is replaced, as the disease progresses, by diminution or loss. Greatly exaggerated knee-jerk does not occur in uncomplicated neuritis.—ED.] Eventually there are paralysis of the extensors of the forearm, disturbances of sensation, paresthesias, ataxia, etc.

10. INJURIES AND TRAUMATIC DISEASES OF THE BONES.

Remarks on Structure, Function, and Strength of Bones.—Bones vary in strength, shape, and size according to the functions that they perform. They are able, by reason of their structure, to withstand strong pressure as well as traction. The adaptation of structure to function is well illustrated by the arrangement of the bony fibers after fractures.

A bone is composed of two varieties of substance—one, hard and compact; the other, spongy and somewhat elastic. In the long bones the compact substance preponderates in the diaphysis, while the epiphyses are composed largely of spongy bone, which, by reason of its elasticity, is well adapted to resist exposure to pressure and strain.

The bones vary as to shape and elasticity in different periods of life. The epiphysis is not ossified, on the average, before the twentieth year. To the elasticity of the bones in childhood is due the fact that fractures occur less frequently, and that they heal more rapidly and perfectly, than in adult life. Investigations have been made by which the strength and elasticity of different bones at different ages, and in comparison with other substances,—such as metals, alloys,

wood, and stone,—have been definitely determined. Messerer gives the following figures in regard to the power of resistance to pressure of different bones: Fracture of the clavicle was caused in men by an average weight of 192 kilos; in women, by a weight of 126 kilos. In one woman the humerus was fractured by a weight of 600 kilos. The average weight for the radius in men was 334 kilos; in women, 220 kilos. For the shaft of the femur, in men, 815 kilos; in women, 756 kilos. The greatest weight withstood by the tibia was 650 kilos, and the minimum was 450 kilos.

(a) Fractures of Bones.

Fractures are by far the most common form of injury to which the bones are subject.

When a bone is diseased, the external force required to fracture it may be so slight as to be almost inappreciable. Bones weakened by rachitis, osteomalacia, syphilis, or tabes are sometimes broken by ordinary muscular contractions.

A healthy bone, on the other hand, possesses a high degree of resistance to external violence, as is shown by the scale of figures previously given. This power of resistance varies with the age of the individual. In children, ossification being still incomplete, the bone is comparatively flexible, and therefore is less subject to fracture. In old age, when atrophy has lowered the power of resistance, we meet with fractures with comparative frequency.

Fractures, of course, occur most frequently among the class of people most exposed to accidents—in workmen between twenty-five and forty-five years of age who are usually chosen for all kinds of heavy and dangerous labor.

According to Bruns, the comparative frequency of fractures in different periods of life may be expressed by the following table:

From birth to the 10th year	5.9 %
“ 10th “ 20th “	8.1 “
“ 20th “ 30th “	12.0 “
“ 30th “ 40th “	15.4 “
“ 40th “ 50th “	13.5 “
“ 50th “ 60th “	14.9 “
“ 60th “ 70th “	12.3 “
“ 70th “ 90th “	17.5 “
(8.7% in a decad.)	

The proportion between fractures according to sex is as follows :

				Male.	Female.
From birth to the 10th year				2.1	: 1.0
“ 10th “ 20th “				5.7	: 1.0
“ 20th “ 30th “				7.2	: 1.0
“ 30th “ 40th “				12.7	: 1.0
“ 40th “ 50th “				6.9	: 1.0
“ 50th “ 60th “				2.9	: 1.0
“ 60th “ 70th “				1.7	: 1.0
“ 80th “ 90th “				1.0	: 1.9

According to this table, fractures occur, on the average, four and a half times as frequently in men as in women.

Fractures are divided into two classes—simple and compound. In the latter the skin and other soft tissues are so injured as to form an open wound, thereby giving entrance to pathogenic bacteria.

Fractures are further classified as complete and incomplete ; the subperiosteal and green-stick varieties belong in the latter class.

In respect to their origin, they are said to be direct and indirect. In indirect fractures the bone is always broken at a distance from the point at which the external force is applied ; a fracture at the elbow or shoulder, for instance, may be caused by falling on the hand, or a fracture of one of the vertebræ by falling on the feet.

The line of fracture varies in direction and extent in different cases ; hence, we speak of oblique, transverse, longitudinal, and spiral fractures, and also of comminuted and multiple fractures.

Certain special forms of fracture deserve mention, as follows :

Fractures caused by bending of the bone : for example, when a wheel passes over a concavoconvex bone, the concave side being down.

Fractures caused by torsion : for example, a fracture of the femur when the individual, standing on his feet, is caught under a falling wall, and at the same moment suddenly and violently twists his body.

Fractures caused by compression : for example, a fracture of the os calcis or of a vertebra as the result of falling and landing on the feet.

Fractures caused by crushing : for example, when a heavy object falls on the foot.

Fractures caused by a tearing force, most frequently due to the action of muscles, and indirectly to that of ligaments : for example, a fracture of the neck of the femur as the result of overtension of the Y-ligament ; of the patella, as the result of overaction of the quadriceps ; of the olecranon, from overaction of the triceps, etc.

Fractures caused by mangling : for example, when the hand is caught between cog-wheels.

Fractures caused by bullet-wounds or by explosions. With the former we have little concern here. The fractures, on the other hand, that are caused by explosions of gas-pipes, of dynamite charges, etc., are met with very frequently in accident-practice.

Without entering upon a discussion of the symptomatology of recent fractures, there is one question that calls

for consideration here. It has often been the subject of controversy between physicians and trades-unions, and may be formulated as follows: Can a person proceed on his way or go on with his work immediately after the occurrence of an accident by which he has suffered—for example, a fracture of the ankle-joint, of a vertebra, or of the clavicle? We must admit this to be possible. The second part of this book contains a number of instances of this nature.

Healing of a fracture takes place by means of the formation of callus between and around the broken ends, the amount of callus formed varying greatly in different individuals.

As the soft callus is gradually absorbed, the thickening at the point of fracture and the abnormal mobility grow less and less noticeable. The period required for complete consolidation varies in different bones and with different individuals, and is influenced also by many minor circumstances. Complete consolidation is not synonymous, however, with recovery of function; to the latter end careful and regular exercise is necessary.

In regard to the published statements of results of the treatment of fracture, we must keep in mind that systems of surgery, as a rule, state the length of time necessary for complete union to take place, whereas the later publications include the time spent in the recovery of function by means of medicomechanical exercises, etc., which may double the period of treatment. The same distinction holds good in regard to the cases discharged from surgical clinics as "cured," in which the "cure" and the recovery of functional power are two very different things.

The Symptoms of Healed Fractures.—Apart from cicatrices,—which, of course, are necessary sequels of compound fractures,—the following points may usually be observed after healing of the fracture:

The bone is still rather soft at the point of fracture, and, especially when the bone of the leg is concerned, it is swollen and thickened. The whole limb is somewhat swollen, while on the leg, and especially on the foot, the skin may be cyanotic. The temperature of the limb may be raised, as can be demonstrated by a skin thermometer; or it may be lowered and may be moist with cold perspi-

ration. The limb is usually shortened and somewhat displaced at the point of fracture; disturbances due to these changes are often apparent in neighboring joints, tendons, and muscles. The muscles of the whole limb are atrophied, which fact goes to prove the functional relation existing among the different groups. The palmar and plantar surfaces feel soft, the aponeuroses not having regained their normal tension. Power over the limb is only partly recovered, and the use of the limb is characterized by uncertain and awkward movements. If the fracture involved a joint, it will be much swollen, and may be inflamed. The joint is stiff in most cases; and is likely to be so, indeed, even when not actually involved in the fracture, if the latter occurred in its immediate vicinity. If the nerves were injured, the resultant paralysis are usually still very well marked. Patients often complain of pain and of being easily fatigued.

Many of the foregoing symptoms entirely disappear; others become permanent. The swellings and the disturbances of temperature gradually subside, while the callus grows smaller and harder, and is usually absorbed in the course of time. The muscles may either partly or entirely recover, or the atrophy may permanently persist, as in cases of ankylosis or hypermobility of the joints, or of paralysis following injuries of the nerves. When the limb is shortened, the muscles undergo the process of adaptation to their new requirements. This process may require considerable time for its completion—in some individuals as much as one to two years, or even longer. Even if the functional power of the limb is only partly regained, the patient learns how to use it to the best advantage, and loses the appearance of awkwardness and hesitancy referred to before. The pain in the limb gradually subsides, as a rule.

In some cases of fracture either union never takes place or it is greatly delayed. This may be due to a variety of causes, such as an insufficient formation of

callus, pseudo-arthritis, the interposition of soft parts, central and peripheral paralysis, or malignant tumors. The symptoms of unhealed fractures are practically the same whatever the cause, and include a false point of motion, loss of functional power, atrophy of the whole extremity, especially below the fracture, and low temperature of the part.

The treatment of those fractures in which healing is delayed, as well as of the part after union has taken place, is chiefly of a mechanical nature, consisting of massage, local baths, electricity, and medicomechanical exercises. The results thus obtained in cases of delayed union and false joints are often remarkable. Removable plaster supports for walking are excellent in cases of pseudo-arthritis of the lower extremity; the formation of callus is stimulated by the exercise, while in addition massage may be practised daily. When union is prevented by the interposition of soft parts, operative interference is, of course, indicated.

Fractures Occurring in Special Occupations.—A class of fractures of great etiologic interest is occasionally observed in healthy, vigorous individuals as the result of a violent or awkward movement or of a misstep while carrying a heavy load. The neck of the femur was the seat of fracture in six of the seven cases I have collected, and in all the cases it was the cancellous portion of the bone that was involved. The following case, to be again referred to in Part II, involved the os calcis, astragalus, and scaphoid :

A stone-carrier, thirty-nine years of age, in good health, lost his wooden shoe from the right foot while carrying a heavy load of stones up a ladder, and was obliged to mount five rungs with his unprotected foot. The fracture was demonstrated by X-rays.

There is no connection between fractures of this nature and spontaneous fractures of diseased bones.

Spontaneous Fractures.—Under the influence of certain pathologic processes—such as tuberculosis, syphilis,

tabes, osteomalacia, rachitis, sarcomatosis, etc.—the bones become softened and are very easily fractured. Ordinary movements, such as taking off the shoes or throwing an object, may suffice. Thiem, in his “Manual,” has cited a number of these cases. I will mention only a few, the illustrations and detailed accounts of which will be found in Part II.

In one case (see Plate 9) a mason, thirty-four years of age, felt something crack in his back on lifting a box of lime. The injury proved to be a fracture of a lumbar vertebra. The cause was tuberculosis.

In another case a man of similar age felt a sudden pain in his right foot after carrying stones up one story. On looking at his foot he found it swollen. The diagnosis was fracture of the os calcis; and the cause, tuberculosis.

In a third case a calciminer, forty-six years of age, while carrying a sack of plaster on his back turned his ankle, and in so doing fractured it. The growth of callus was very abundant. The diagnosis was fracture of the right malleolus; and the cause, tabes.

In the last two cases no damages were allowed the patients, although spontaneous fractures are covered by the Accident Insurance Law, as it could not be shown that the injury was caused by an accident in the sense in which the term is understood by the law.

Fatal Results of Fractures.—Fractures may cause death by reason of fat embolism, by the entrance of air into the circulation, or, in rare instances, by internal hemorrhage.

(b) Contusions of Bones.

Accidents such as blows, kicks, falls, etc., instead of causing fracture, may only crush the part and lead to an acute traumatic periosteitis, and to an inflammation of the soft tissues. Sometimes the inflammation extends to the medulla as well, but under favorable circumstances this soon subsides. Bones that are but slightly protected by soft parts—such as the tibia, for instance—are most liable to attacks of traumatic periosteitis. In the case of the tibia the infiltration of the periosteum is easily demon-

strated by the indentations left by pressure of the fingers. Traumatic periosteitis yields readily to treatment, as a rule, recovery being complete in from two to four weeks. In other cases the pain and swelling persist much longer, and it is necessary to keep the patient in bed in order to effect a cure.

Open wounds of the periosteum and of the bones are not dangerous if proper antiseptic precautions are taken. Sometimes when the cicatrix is attached to the bone, it gives rise to much pain, especially if nerve-branches are involved in its growth. In Part II will be found the history of a case of this kind, following a contusion of the tibia, that I have had under observation for eight years.

Infectious periosteitis occurs as part of an infectious osteomyelitis, the involvement of the periosteum being the most conspicuous feature of the disease.

(c) **Traumatic Osteomyelitis.**

Although traumatism can not cause an infectious osteomyelitis without the presence of the specific bacteria, it does act as the indirect cause of the disease, since the injury done to the tissues furnishes the bacteria with the conditions best suited to their development. The injury is not necessarily produced by violence: bodily strain or exposure to severe cold may be sufficient.

The danger of infection through the open wound of a compound fracture does not need emphasis; an insignificant wound of the skin may, however, serve equally well for the entrance of pathogenic bacteria into the system.

After the osteomyelitis subsides, the bones regain their strength and usefulness; a subacute or chronic inflammatory process sometimes, however, persists for years or for life. Suppurating sinuses leading down to the medullary cavity and sequestra are features of this chronic process. The individuals thus affected are nevertheless able to work, unless an acute inflammation sets in. The following will serve as an example.

A stone-carrier whom I often had occasion to examine continued to carry stones on his left shoulder for about sixteen years, in spite of the existence of a suppurating sinus on the left arm, about the width of two fingers below the surgical neck of the humerus.

Long-continued suppuration leads in the end to serious difficulties. There is an extensive growth of scar-tissue, often firmly attached to the bone; the joints become ankylosed; disturbances of circulation and nutrition manifest themselves, especially when the lower extremities are involved; the part undergoes atrophy, etc.

An extension of infection through metastasis is an ever-present danger in cases of osteomyelitis. If a joint becomes involved, its functional power is apt to be permanently destroyed.

When a limb is the seat of an osteomyelitis during childhood, its growth is temporarily checked, and it may, in consequence, never attain its full development.

The **treatment** of the acute or subacute stage is purely surgical. When the process has become chronic, only symptomatic treatment can be employed, as a rule. The patients should be instructed how to care for the wound when a new abscess breaks open, and advised to consult a physician as soon as possible. The inability for self-support must be judged according to each individual case.

(d) **Tubercular Osteitis.**

Traumatism plays the same part in the etiology of this disease as in osteomyelitis. In the majority of cases the individual is already tubercular, although the process may be latent, and the injury may be of a very trivial nature. It has been stated that tubercular osteitis is most likely to develop after just such injuries. The process is usually located in the cancellous tissue; it may, however, extend to the compact bone. The articular surfaces are involved more often than any other part of the bones.

II. INJURIES AND TRAUMATIC DISEASES OF THE JOINTS.

(a) Contusions of Joints.

By contusion of a joint is commonly understood an injury of which the only apparent effect is a hemorrhage into the joint. It may be caused by a kick, a fall, the caving-in of a wall or of the sides of an excavation, or by blows from falling objects.

It is often difficult, when the joint is much swollen, to differentiate between a simple contusion and a fracture of the joint, and in many instances the latter is not diagnosed for some time after the injury. Statistics collected since X-ray examinations came into use show a much diminished proportion of cases of simple contusion.

The effusion caused by a simple contusion, when treated by rest, elevation, and compresses, is generally rapidly absorbed, and the cure is completed in a few weeks. When certain joints are involved, absorption may be somewhat slower, and it is always delayed by a too early use of the joint. The atrophy of the muscles connected with the joint persists for some time after subsidence of the inflammation and absorption of the effusion, but can be overcome by conscientious use of massage, medico-mechanical exercises, and electricity. In some cases, particularly in those in which absorption of the effusion is delayed, movement of the joint calls forth rubbing, cracking sounds, which are doubtless due to hypertrophy and proliferation of the synovial folds and fringes, in combination with a subnormal secretion of synovial fluid. The condition is not, as a rule, painful, nor does it interfere to any appreciable degree with the action of the joint.

(b) Sprains.

Two varieties of sprains can be distinguished. In the first variety the articular ends of the bones suffer a mo-

mentary mutual displacement, by reason of which the ligaments of the joint are strained, and both ligaments and capsule are somewhat torn. Numerous small blood-vessels are torn across at the same time, and an effusion of blood into the joint results in consequence. Swelling and inflammation of the joint naturally follow. In the second variety the articular surfaces are injured by being struck against each other. While the outward symptoms—swelling, effusion, inflammation, and pain—are the same as in the first variety, the capsule and ligaments remain intact.

The injury resulting from sprains is not necessarily confined to the soft tissues and to an effusion of blood. In many cases the term includes a fracture as well, and in consequence of the extreme strain upon the ligaments at the time of the accident, a bit of the bone is not infrequently torn off at one of their points of insertion.

Sprains are apt to heal more slowly than simple contusions of the joint. In many cases the result remains unsatisfactory in spite of a long course of treatment. This is sometimes due to the development of tuberculosis, sometimes to the existence of a subluxation that has occurred subsequently to the original injury. Poor results are in some cases to be ascribed to too prolonged a use of fixation-bandage, which leads to partial ankylosis. Loose-jointedness is another evil sequel of sprains that is occasionally met with. The condition may depend on the laceration of a ligament or of the capsule, or on the fact of a bit of bone or cartilage having been pulled off by a ligament, which remains unattached in consequence. The loose bit of bone or cartilage acts as a foreign body in the joint, causing great pain at times.

The **treatment** of sprains is the same as that for contusions ; muscular atrophy and stiffness of the joints demand after-treatment, and loose-jointedness is to be overcome by the restriction of a suitable bandage.

(c) Dislocations of Joints.

While in case of sprains the articular surfaces immediately right themselves, in dislocations they remain separated after displacement until artificial reduction is practised. The separation of the articular surfaces is necessarily associated with more or less extensive laceration of the capsule and ligaments. The laceration of the capsule, at all events, is a regular accompaniment of a dislocation. Blood-vessels, and very often branches of nerves, are torn, while pieces of bone are chipped off at the same time, in which case the term luxation-fracture is perfectly applicable. The swelling that takes place in consequence of a dislocation may not be appreciably greater than that seen after sprains.

The degree of force required for the reduction of a dislocation often exceeds that which produced the injury; the process of reduction, therefore, is not unattended by danger. The capsule and ligaments may be further lacerated, bits of bone may be chipped off, or nerves may be torn. After reduction the joint and the neighboring tissues appear swollen. Swelling and ecchymosis are still seen at the time when the fixation-bandage is removed; and if the part has been kept immobilized for any length of time, the nearest other joint of the limb will show only limited mobility, while the affected joint itself is completely stiffened. When the shoulder-joint has been thus treated, for instance, the arm, after removal of the bandage, will be found to be fixed at the angle at which it was held, while the mobility of the elbow is restricted. The muscles about the joint, as well as those extending over the next joint, are seen to be atrophied. In case of injury to the nerves, paralysis of the parts supplied by them will become evident, the permanence of the paralysis depending on the severity of the injury. Mobility of the joint can often be restored by treatment; in many cases, however, partial ankylosis is caused by cicatricial contrac-

tion of the lacerated capsule. The limb necessarily assumes an abnormal position in consequence of these contractions of the capsule; the muscles and tendons become displaced and undergo atrophy. Occasionally, the position, by indicating the point of rupture of the capsule, gives a clue to the variety of the dislocation. In favorable cases the ankylosis can be overcome by treatment; in others, it remains permanent.

Sometimes, instead of ankylosis we have hypermobility of the joint—loose-jointedness.

The principal **therapeutic indication** is the recovery of normal mobility, which condition is best achieved by means of passive and active exercise, carried out by the operator and on an appropriate apparatus. The atrophy is overcome at the same time. Massage is helpful for the atrophy, but is of little use in the end unless mobility of the joint is regained. Exercise, massage, and, above all, electricity, are to be recommended for the paralysis. Hypermobility must be treated by means of a suitable bandage.

Subluxation.

This injury frequently escapes diagnosis, and being dismissed as a contusion or a strain, the displacement is not reduced. In other cases an even more harmful blunder is made: that of diagnosing a fracture of the joint and immobilizing the latter. Hence, the consequences of subluxation are apt to be serious. While the joint remains swollen, it is difficult to recognize the displacement; as the swelling goes down, the displacement becomes more and more evident. Diagnosis is less difficult in the more severe cases that approach complete dislocations; and in these reduction is, of course, practised. In some situations—in the knee-joint, for example—a subluxation closely resembles a healed fracture of the condyle.

The characteristic signs of subluxation are as follows: There is mutual displacement of the articular surfaces, varying in degree. The surfaces remain for the greater

part in contact with each other ; the displacement may be entirely lateral or it may be partly rotatory, the muscles and tendons connected with the joint being displaced accordingly. The appearance of the joint is changed : it is enlarged, and its outlines, depressions, and folds are less marked than normal ; the muscles with which it stands in relation have atrophied. The joint is usually flexed. Mobility is impaired ; it is, however, never entirely lost. Motion is painful, the pain having a lasting character. The joint may remain in a state of inflammation for a long time ; massage and exercises, unless very cautiously employed, are apt to increase and to prolong the disturbance.

As regards **treatment**, the first aim is to subdue the inflammation by means of rest, favorable position, and compresses. Afterward, when the exact relation of the articular surfaces has been clearly determined, exercise may be begun with great caution. I have found movements of resistance to gradually increased force to be especially valuable. If the pain grows worse, exercise should be curtailed. Muscular atrophy is treated, as usual, with massage and electricity. The results of treatment are often excellent, but not in all cases ; the condition of the patient is often only partly relieved by a long course of treatment, and sometimes the pain is not in the least subdued.

Fractures of Joints.

The **prognosis** for fractures involving joints is much less favorable than for fractures of the shaft of the bone. The reason for this lies in the structure of the joint itself. The articular cartilages, lined with synovial membrane, are fractured no less than the bone, and an inflammatory exudate is poured out into the joint. The most urgent indications, therefore, are to allay the inflammation and to cause the absorption of the exudate and the union of the fractured parts. All energetic mechanical treatment having for its design the preservation of function in the joint must, therefore, be delayed. Under these conditions it is

often quite impossible to prevent permanent ankylosis, especially when muscular action causes dislocation of the fractured parts of the joint. It is advisable, in view of the foregoing, to begin careful passive movements of the joint at the earliest possible moment—as soon, in fact, as the inflammation and exudation subside. Certain active movements are also permissible.

The prognosis is more favorable for fractures that occur in the vicinity of the joint but do not actually involve it. The prevention of ankylosis in these cases is a less difficult matter, but there are a number of causes that lead to it, nevertheless. Sometimes the inflammation extends to the joint, or there may be a dislocation of the latter secondary to a similar complication at the point of fracture; in other cases the continued immobilization of the joint necessitated by the treatment in itself suffices to produce ankylosis. The limb is often fixed at an angle. A dislocated and ankylosed joint is of unfavorable prognosis as to function; but if movement can be begun early, it is often possible, with patience and unremitting attention, to overcome the adhesions.

Fractures with Dislocation.

This double injury occurs with comparative frequency; it is seen in classic form in fractures of the vertebræ, especially in the cervical and lumbar regions; of the joints of the extremities, the elbow is the one most liable to be involved. The prognosis depends almost entirely on the skill shown in reduction and fixation. If improperly treated or if left unreduced, complete ankylosis is sure to follow.

If by refracturing an ankylosed joint it can be fixed at an angle more favorable to the usefulness of the limb, the operation should be strongly urged. An arm fixed at a right angle at the elbow, for example, is a comparatively useful member, while it is less and less so the straighter it becomes.

Traumatic Arthritis.

This develops as a result of contusions, sprains, and dislocations, of fractures not only of the joint itself, but occurring in its immediate vicinity, and of cellulitis, etc. Arthritis is often to be regarded as a symptom of one of the injuries enumerated; the prognosis is generally favorable for a rapid recovery, but with advancing years there is a tendency for the acute inflammation to develop into a chronic form. In chronic arthritis the joint is enlarged and there is a proliferation of the synovial folds of the capsule, which causes the well-known cracking sounds on motion. In some individuals there seems to exist a tendency toward such proliferation. Chronic arthritis is not, as a rule, painful; nor does it interfere to any marked extent with the mobility of the joint. If the inflammation becomes tubercular or purulent, however, or if it is superseded by an arthritis deformans, the case is thereby given a serious aspect.

Articular Rheumatism, Gout, and Arthritis Deformans.

Traumatism may act as the indirect cause of acute articular rheumatism by lowering the resistance of the joint, thereby rendering it more susceptible to attack by the cocci of the disease.

The question of the traumatic origin of gout can be similarly explained. It is beyond doubt, on the other hand, that arthritis deformans can develop as a direct sequel of traumatism. While fractures are the most common form of injury leading to the disease, it may also develop after contusions, sprains, and dislocations. Being a chronic disease, it develops slowly; years may elapse before the deformity that it causes reaches an extreme degree. The synonym of "arthritis pauperum," which is applied to the disease, is doubtless based on the fact that it is most frequently seen in working-men who do hard work and live poorly. There is no doubt that the

development of arthritis deformans is favored by the effects of hard labor, especially when undertaken too soon after an injury, before the joint has completely recovered, in combination with lack of care and poor and innutritious food. The injuries, whether of trivial or serious nature, to which the joint is exposed during work or at other times are also of etiologic importance.

A joint affected by arthritis deformans gradually becomes misshapen; its power of motion is diminished, and in the end is completely lost. The articular ends of the bone in a well-developed case are in part atrophied, in part covered with hypertrophic processes, while ligaments and tendons have undergone ossification—a condition that is well expressed by the term osteo-arthritis. The disease entails a great deal of suffering at times, especially aggravated by the presence of free ossified nodules in the joint.

The **prognosis** as to usefulness of the joint is very bad; the disease is incurable, although some relief may be gained by means of baths, compresses, inunctions, and rest. Massage should not be attempted. Affected individuals can not do heavy work, but are often able to perform light tasks.

Tubercular Arthritis.

By causing inflammation of a joint, traumatism may be indirectly responsible for the subsequent development of tuberculosis in the same. There are two ways in which infection of the joint may occur: In a tubercular individual the tubercle bacilli may, by the process of metastasis, establish themselves at the site of injury, the resistance of the tissues having been lowered by inflammation; or there may be a primary tubercular arthritis as the result of infection subsequent to the injury.

Tubercular arthritis is more frequently observed after comparatively slight injuries, such as contusions and sprains, than after those of a more serious nature, such as fractures. As fractures, however, are doubtless over-

looked in many cases of so-called sprains, their probable influence on the development of the tubercular process must be admitted. I have myself observed a number of cases of tubercular arthritis following fracture. Conditions favorable to the development of tuberculosis prevail among working people, who do hard work and eat poor food, and scarcely enough of that, while they drink regularly and to excess. They live from hand to mouth, are frequently out of work, and at such times are likely to drink more heavily than usual. The dwellings in which they live are poorly built, and are frequently infected with tubercle bacilli, while tuberculous and healthy members of a family live together in close companionship. It is not to be wondered at that a vigorous working-man who is confined to his room for a time by a sprained ankle, for instance, should, under such conditions, develop a tubercular arthritis. Its development is favored, moreover, by a too early use of the injured joint.

Tubercular arthritis is characterized by its slow course and its resistance to all methods of treatment. When it develops in consequence of an injury, it is not easily recognized in its early stages, and considerable time—in some cases as much as a year—may elapse before a positive diagnosis can be made. The symptoms pointing to the disease are pain, swelling, and diminished mobility of the joint, with gradual changes in its shape. The general health deteriorates at the same time, and the patient loses flesh perceptibly. Tubercular arthritis can be diagnosed by means of X-ray photographs before the general symptoms become apparent.

The time required for the development of the disease after the occurrence of the injury is variable. The process may begin as soon as the acute symptoms of the traumatism subside, or it may not appear for years afterward. In one case of dislocation of the scaphoid that was under my observation five years elapsed before the tubercular process, which attacked the whole tarsus, became evident.

It is hardly necessary to state that the **prognosis** of tubercular arthritis is unfavorable. We must not be misled by occasional remissions during which the swelling and pain somewhat diminish, for the disease is very liable to crop out in another spot, which it reaches by metastasis.

In **treating** cases of tubercular arthritis we should strictly avoid all active mechanical procedures, such as massage and movements of the joint, since by these the inflammation is aggravated. Good nourishment and favorable surroundings are the best therapeutic agencies.

Arthropathy.

The affection of the joints that occurs in syringomyelia, and more especially in tabes, under the name of arthropathy, may be directly caused by traumatism. The bones that are affected by the diseases just named become so fragile that the ankle-joint, for instance, may be fractured by a wrench due to a misstep. There is an excessive growth of callus in these cases, leading to deformity of the joint. In tabetic patients the callus is quite characteristic of the disease.

In respect to **treatment**, we are powerless to do more than relieve the condition of the patient to a certain extent; results in this limited field are often quite satisfactory.

Resection of Joints.

The most important points connected with ankylosis and loose-jointedness have already been discussed. It remains to mention the conditions that follow resection. As a result of the operation we may have to deal with a rigid joint, a loose joint, or a newly formed mobile joint. The chief objects of the operation are to remove the diseased or useless portion of a joint and to leave the part in as serviceable a condition as possible. If a stiff joint is to be provided, it is to a certain extent in the power of the surgeon to fix it in the most advantageous position. If,

because of the removal of a large portion of the joint, the operation results in loose-jointedness, the usefulness of the limb is, as a rule, greatly impaired. A workman in excellent health, whose case I have observed for about nine years, has an elbow-joint in this condition. He is obliged to wear a jointed support, by the aid of which he is able to move his arm a little ; without it, the arm hangs helpless at his side.

Only a very limited degree of motion can be expected after resection, but it often suffices to facilitate the use of the limb as a whole.

12. THE INFLUENCE OF TRAUMATISM ON THE DEVELOPMENT OF TUMORS.

Among the malignant tumors that belong under this heading there are only two that demand our special attention : namely, the carcinomata and the sarcomata. [For a very instructive clinical and pathologic study on the influence of traumatisms in the development of sarcomata, see W. B. Coley's article on "The Relation between Injury and Sarcoma," "*Annals of Surgery*," March, 1898.—*Ed.*]

The process of development differs in the two varieties of tumor. In some individuals the irritation and inflammatory reaction following traumatism seem sufficient cause for the development of a sarcoma in hitherto normal tissue. A carcinoma, on the other hand, finds its starting-point in scar-tissue ; whether this has grown as the result of traumatism or of disease is a matter of no consequence. Constant irritation or repeated traumatism may so affect the scar-tissue as to cause or favor the development of carcinoma. Traumatism may, furthermore, hasten the development of a growing carcinoma, or it may lead to sudden death by loosening bits of the cancerous tissue, which are then carried into the circulation.

The dangers involved in the growth of carcinomata do not need emphasis. In respect to sarcomata, it should be

remembered that when they develop in bones, the latter become extremely liable to spontaneous fracture. Mention of cases of carcinoma and sarcoma for which insurance was allowed, traumatism having been recognized as the indirect cause of the disease, can be found in the annals of the State Insurance Bureau.

13. CASES OF POISONING.

Accidents due to poisoning are included in the list of accidents for which, according to the Accident Insurance Law, payment of insurance may be demanded. The poisoning of miners by carbon monoxid, or of watchmen in new buildings by the same gas, poisoning by benzol and benzin, poisoning *en masse* by chlorin or by the fumes of petroleum products, are all instances of such accidents. We have not space to discuss the symptomatology of such cases. The law applies more especially, however, to cases of poisoning incidental to employment in special trades and manufactures, which are really better looked upon as diseases peculiar to such trades.

Alcoholic Intoxication (Chronic Alcoholism).

Alcoholic intoxication is so wide-spread an evil among working people that it deserves some discussion here. The evil is so firmly implanted in all grades of society that it may well be regarded as a national disease. Alcohol is thought by working-men to be a proper and essential article of diet. It is not in place here to cite statistics relative to the consumption of alcohol and the consequences of the same. We should, however, bear its effects in mind, especially as they relate to the causation of injuries, and as they influence the prognosis. Acute alcoholic intoxication unquestionably leads to many accidents.

Chronic alcoholic intoxication, or chronic alcoholism, plays no less important a part in the etiology of accidents,

entailing, as it does, a loss of power of body and mind, thereby rendering the individual more liable to injury. Chronic alcoholism does not necessarily imply frequent drunkenness. The regular daily consumption of small quantities of alcohol, especially in the form of whisky, very often suffices to cause the disease in individuals who have never been drunk in their lives. Nor does it always depend on the amount regularly consumed: weak, ill-nourished, or nervous individuals, or those in whom there is a hereditary predisposition, develop symptoms of alcoholism after taking relatively small quantities, and in much less time than others of naturally strong constitution. The cumulative action of alcohol is easily understood if we remember that traces of the poison can be demonstrated from three to seven days after its introduction into the system on a single occasion. Considering that alcohol is taken regularly into the system for years, as is the custom among some working-men, who, moreover, live poorly, and often suffer deprivation, the development of the symptoms of chronic alcoholism at one time or another seems unavoidable. The symptoms of the disease are manifold, and consist chiefly of pathologic changes of various organs, as follows:

1. The nervous system, including: (a) Central disturbances (delirium tremens, paranoia, paralytic dementia, epilepsy). [This statement should be somewhat qualified. Alcoholism, complicated or uncomplicated by traumatism, may cause an almost endless chain of mental symptoms; but it can hardly be said to cause either paranoia or paralytic dementia. Epileptiform convulsions also, when induced by alcohol, differ in important particulars from true epilepsy. All three of these diseases are essentially incurable, whereas in the majority of cases symptoms caused by alcohol disappear upon the withdrawal of the poison.—Ed.] (b) Peripheral disturbances (alcoholic neuritis).

2. The circulatory system.

3. The respiratory tract.

4. The digestive tract.

5. Muscular system.

Any one group of symptoms may predominate in a given patient. It would lead us too far to enter upon a discussion of the far-reaching symptomatology of the disease. Many diseases of the nervous system, including those of traumatic origin, display symptoms similar to those of chronic alcoholism, which may, in fact, be the underlying cause of these same nervous diseases. We need only to study insane and criminal statistics to appreciate that alcoholism is responsible for the development of many mental diseases. A regular consumption of alcohol leads also to heart-disease, while its evil effects can be directly or indirectly traced in the history of cases of pulmonary tuberculosis, gastric ulcers, diseases of the liver, kidneys, and other organs.

We frequently meet with some of these conditions in patients we see in accident-practice. In examining a patient after injuries it is not only valuable, but usually quite essential, before forming an opinion of his case to ascertain his habits regarding the use of alcohol. It is a good plan to question him as to his manner of living, to cause him to tell what he eats and drinks, as in this way we gain a knowledge of his social status that may greatly influence our judgment of the case.

14. INFECTIOUS DISEASES.

Traumatism may stand in either direct or indirect relation to infectious diseases; in the former instance the infectious material enters the body through wounds of the skin, which may be serious or very trivial, as in case of phlegmonous inflammation following slight injuries of the finger. The same holds good of other infectious processes, such as malignant pustule, tetanus, glanders, and malignant edema. The relation between traumatism and infectious process is none the less direct when the infectious

baacteria enter a wound some time after the injury. This occurs in cases of erysipelas, for instance. The very fact that the local entrance of the bacteria of the diseases previously named presupposes the existence of a wound is sufficient evidence of itself of the direct relation that exists between traumatism and the infectious process. Tuberculosis of the skin may develop similarly, as the result of direct implantation. We are, therefore, warranted in speaking of a tuberculosis of the skin of traumatic origin.

The relation between traumatism and the infectious process is, on the other hand, an indirect one in cases of tuberculosis of the lungs and joints, in which the tubercle bacilli enter the body by way of the respiratory or digestive tract. Traumatism serves to lessen the resistance of the part on which it acts, which is, in consequence, subject to attack by the tubercle bacilli circulating in the blood.

The bacilli of **anthrax** may enter the body through the respiratory and digestive tracts, as well as through wounds. According to the State Insurance Bureau, all such cases are regarded as accidents. Anthrax bacilli are found on the skin, wool, and hair of an animal suffering from the disease, also on brushes made from such hair. The disease develops as a local affection of the skin under the name of malignant pustule; when it attacks the lungs or intestine, it is known as "wool-sorters' disease." Cattle and sheep are the animals most subject to the disease; in human beings it is, therefore, most often seen in butchers, farmers, shepherds, tanners, brush-makers, and produce dealers.

The incubation period of malignant pustule is three days. If it remains localized, it is curable; but if infection becomes general, the prognosis is very grave.

Symptoms.—At first there is a small pustule surrounded by a reddened area. The pustule rapidly dries up, leaving a blackened scab. The surrounding tissue is much indurated. The induration spreads rapidly until the whole extremity becomes the seat of an intense, brawny

edema. The lymph-nodes are swollen. If the course of the disease is favorable, the scab gradually separates and is thrown off. Progressive edema and high fever are unfavorable signs : they are liable to be followed by delirium, diarrhea, rapid loss of strength, ending fatally within a week.

Prognosis.—Ninety per cent. of these cases recover.

Wool-sorters' disease, as the name indicates, affects those who spend their working hours in close contact with wool, and contract the infection by inhalation of anthrax spores. Persons handling infected skins and hides are exposed to the same danger. The symptoms are those of a septic bronchopneumonia ; anthrax spores can be demonstrated in the sputum. The onset is marked by a chill, fever rising to 40° C., soon followed by the low temperature of collapse. The subjective symptoms are headache, a feeling of oppression, shortness of breath, and great weakness. The most important objective symptoms are cyanosis, involvement of the pleura and lungs, cardiac weakness, and cold extremities. Death usually occurs in two days ; in five or six days at the latest.

The **prognosis** is bad.

Anthrax of the intestinal tract is characterized by a sudden onset, with intense diarrhea, vomiting, cyanosis, and collapse. The **prognosis** is bad.

Tetanus (lockjaw) is caused by the tetanus bacillus, which invades the body through a wound. The bacillus is found in the soil, in dust, in heaps of refuse, in manure, and in dung. It may be carried into the tissues by a splinter of wood or glass or may enter through any wound of the skin. The symptoms of tetanus may appear almost immediately after the injury, or the incubation period may last for days or weeks. In one case of my own the patient, a boy ten years of age, died in from one to two hours after receiving the injury, with characteristic symptoms of tetanus. He had been running barefoot over a heap of refuse, and a small sliver of glass had entered his great toe.

Symptoms.—Tonic convulsions, consciousness being retained. At the onset there is pain around the wound, and the patient is restless, sleepless, and anxious. There are aching pains and rigidity of the muscles of the jaw, pharynx, and neck, followed by tetanic muscular spasms. The drawn facial expression is characteristic. Pareses, and even paralyzes, are said to be sequels of the disease.

The **prognosis** is grave.

Glanders.—This disease may, under certain conditions, also rank as an accident, as when the specific bacillus is carried into a wound by direct contact with an infected horse or ass.

Acute glanders is fatal. The incubation period lasts from three to eight days, and is followed by symptoms of gastric disturbances, pains in the limbs, and a feeling of fatigue, while characteristic nodules, and subsequently suppurating ulcers, develop at the site of infection. A rash appears on the skin, and there is a sanguinopurulent discharge from the nose; the fever increases, and death occurs in from one to three weeks.

Chronic glanders is characterized by aching rheumatoid pains, lymphangitis, swelling of the glands, ulcerations, and moderate fever. There are successive crops of abscesses, first in one part of the body and then in another. The fever is moderate. The disease may last for months, or even for years.

Malignant edema is an infectious disease of which the specific bacillus is found in soil that has been treated with manure, in dirt, in dust, and in drainage. The disease occurs in man in consequence of infection through a wound. The incubation period may be very short; the edema may begin to appear at the site of the infection in from twenty-four to thirty-six hours. It extends to the surrounding tissues and leads to the formation of foul, decomposing ulcers. The fever rises and becomes very high, and is accompanied by delirium. Death may occur within a few days.

Tuberculosis.—Tuberculosis is the most important of all infectious diseases, being the cause of death in more than one-seventh of all cases. The agent of infection, the tubercle bacillus, enters the body, as a rule, through the respiratory organs, but may enter it by way of the digestive tract or the skin.

Unhygienic dwellings, overcrowding, poor and insufficient food, all act as predisposing causes; a hereditary tendency is also of recognized importance. The disease is chiefly disseminated by close contact with infected individuals. It is not surprising, therefore, that tuberculosis is especially rife among working people.

We find, in studying the relation between traumatism and tuberculosis, that an accident often awakens latent tuberculosis to local or general activity, or hastens the course of the disease when it is already fully developed. In treating accident-cases in tubercular individuals we often find the progress of the case materially influenced by the preexisting disease, and are obliged to modify both treatment and prognosis accordingly. Since diseased tissues furnish the favorite nidus for the growth of tubercle bacilli, it is not surprising that tuberculosis is most liable to develop as a local process after traumatism.

The tuberculosis of skin and joints has already been discussed. In the part devoted to special structures we shall meet with many illustrations of its development in other parts of the body.

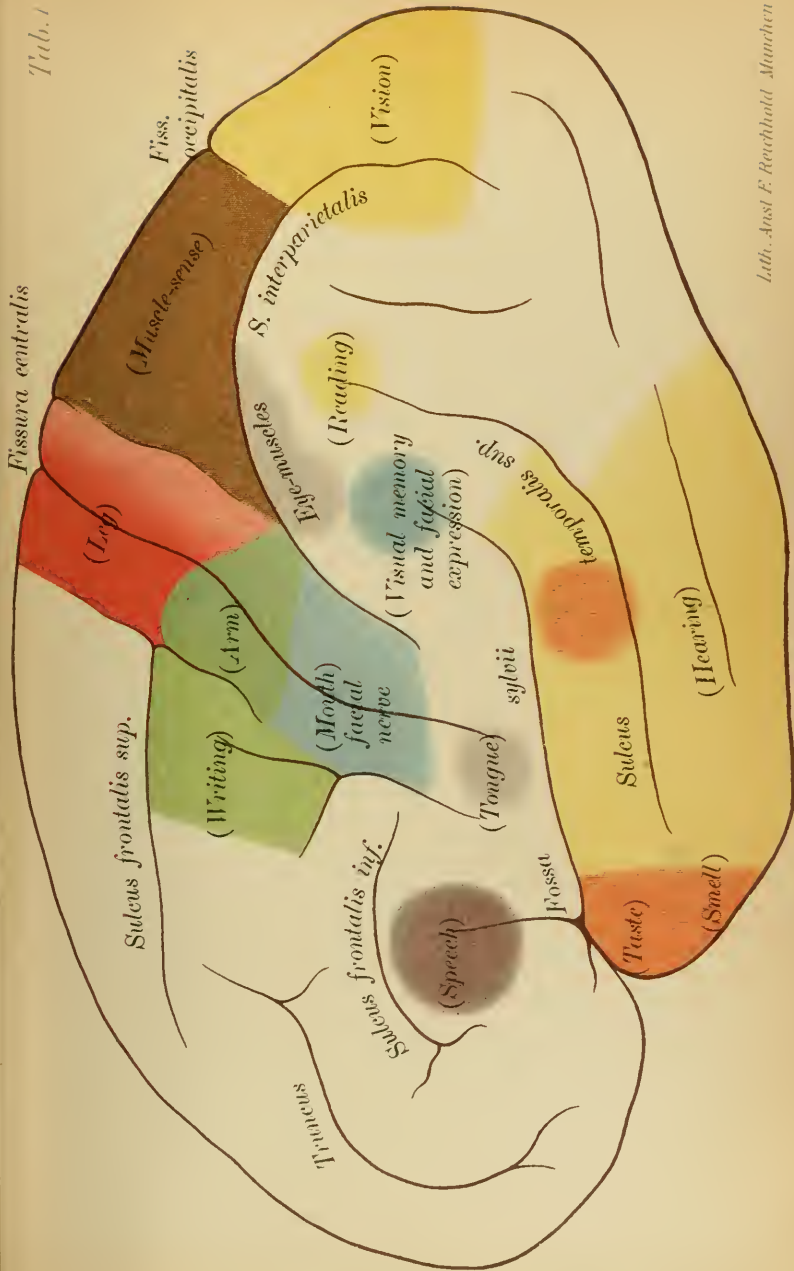
PART II.

I. INJURIES AND TRAUMATIC DISEASES OF THE HEAD.

Anatomophysiologic Considerations.—The strength of the skull varies greatly in different individuals. When the cranial bones are thick, severe blows often cause no serious symptoms. The bones may be so thin, on the other hand, that even a slight contusion proves fatal. In general, we must rely on the anatomic fact that the bones of the cranial vault are stronger than those at the base, and that the latter have many points of weakness that give way to external violence.

It is by no means necessary that every force acting on the skull should cause a fracture; on the contrary, the skull is sufficiently elastic to endure many blows and concussions without injury. But when the limits of elasticity are exceeded, fracture results. Since the brain is the center of many important vital functions, the question in every head-injury at once arises as to whether there is a lesion of the brain or its membranes. For the understanding of many head-injuries it is accordingly of great importance to be familiar with cerebral topography.

Plate I (from Bardeleben's "Atlas für topogr. Anatomie") gives a very clear schematic representation of the centers lying on the lateral convexity of the brain. From the physiologic standpoint the whole lateral convexity can be divided into two regions—an anterior and a posterior. The division is made by the fossa of Sylvius, by the posterior limb of the Sylvian fissure, and by the postcentral fissure. The anterior region is known as the motor region, since it gives rise to the pyramidal tract—the tract of voluntary movements. Irritation of this region causes involuntary contractions of the muscles of the opposite side, or, if the irritation is continued, convulsions (Jacksonian epilepsy). Destruction of this region causes crossed paralysis. Thus, for example, should a tumor develop in the upper extremity of both left central convolutions at the spot marked Bein (leg),—i. e., in the leg-center,—the pressure of the tumor would act as an irritant and would cause involuntary movements of the right leg. Since the irritation would also affect the neighboring centers, the muscles of the right arm and of the right side of the face would be successively thrown into spasm: in other words, a progressive Jacksonian epileptic attack would result. If, later, as the tumor grew, the paralytic action exceeded the irritative, a progressive paralysis of the right leg would ensue.



Injury to the region marked *Schrift* (writing) causes a loss of the movements used in writing, while the other movements of the arm are not interfered with. Similarly, injury to Broca's region causes a loss of those finer movements of the lips, palate, larynx, and tongue that are necessary for speech, while the coarse movements in these muscles are retained. The center for the coarser movements of the lips is situated in the region marked *Mund* (*facialis*) (mouth—facial nerve); that for the coarser movements of the tongue in the region marked *Zunge* (tongue). The center for the coarser movements of the palate and larynx is probably behind the tongue-center. The motor, speech, and writing centers are on the left side of the brain. The function of the corresponding regions in the left hemisphere is not known with certainty.

Most motor centers are connected with the opposite side of the body only. The centers for the trunk-muscles and eye-muscles are exceptions to this, as both of these centers have connections for both sides of the body.

It is to be especially emphasized that individual cerebral centers are not sharply defined, but overlies one another.

The sensory region of the convexity is divided into three sections:

1. The region of the muscle-sense, in the superior parietal lobule. When this is destroyed on the left side, the patient is unable, with closed eyes, to recognize the position of passive movements in the limbs of the right side.

2. The visual area, situated posteriorly to the parieto-occipital fissure. It is probable that the part of the visual area situated on the lateral convexity is especially concerned with visual memories, and has nothing to do with sensations of sight. Destruction of this area leads to "mind-blindness": *i. e.*, the patient sees perfectly well, but is no longer able to recognize objects. The "reading" area belongs to the visual area. When destroyed, the patient can still see the letters, but does not recognize them.

3. The centers for hearing, taste, and smell, in the temporal lobe. Injury to the parts marked *Hören* (hearing), *Schmecken* (taste), and *Riechen* (smell) causes disturbances in hearing, taste, and smell, most marked on the opposite side. Injury to the region marked *Sprach-verständniss* (understanding of language), the so-called *Wernicke* region, causes sensory aphasia; the patient hears perfectly well, but understands nothing (*Ziehen*).

Injuries and diseases of the cranial nerves give rise to the following symptoms:

Injury of the olfactory (nerve of smell, not crossed) in its center affects the power of smell. (When smell is lost, examination for syphilis, polypi, etc., is imperative.)

The optic nerve is a half-crossed nerve. The left optic tract supplies the two left halves, and the right optic tract supplies the two right halves of the retina. Injury to the right optic tract, accordingly, results in loss of sight of the right halves of both eyes.

The oculomotorius, the motor nerve of the eyeball, contains uncrossed fibers, which govern the contraction of the pupil, and crossed fibers, such as those for the movements of the eyeball and the upper eyelid.

When the nerve is injured, there result the following symptoms :

Drooping of the upper lid (ptosis), paralysis of accommodation with permanent fixation for distance, divergence outward and downward with double vision, dilatation of the pupil (mydriasis paralytica), and prominence of the eyeball through the one-sided action of the superior oblique muscle.

The antagonist to the motor oculi is the sympathetic nerve. It contains fibers for the dilatation of the pupil. Irritation of this nerve sometimes causes symptoms similar to those of third-nerve palsy. The sympathetic nerve also contains vasodilator and vasoconstrictor fibers and those that govern the sweat-glands of the head. When, therefore, there is a unilateral pallor or flushing or sweating of the face, a lesion in the sympathetic nerve must be thought of.

The trochlear nerve (fourth cranial), the nucleus of which lies in the vicinity of the nucleus of the third cranial nerve, supplies the superior oblique muscle. Paralysis of this nerve causes slight upward and inward squint and double vision. [For the diagnosis of this affection examination of the double images is usually necessary.—ED.] The abducens nerve (sixth cranial nerve) supplies the external rectus muscle. When this nerve is paralyzed, there are double vision and internal strabismus.

The trigeminus (fifth cranial nerve) is, through its extensive branchings, a very important nerve. Injuries to the first branch cause anesthesia of the eye, which often results in ulceration. Injuries to the second branch, which is especially rich in sensory fibers, cause the symptoms known under the name of "*tie douloureux*": viz., twitchings of the face, watering of the eye, increased nasal secretion, severe facial neuralgia, etc. Injuries to the third branch cause weakness in the muscles of mastication and loss of taste in the anterior two-thirds of the tongue.

The facial nerve (seventh cranial nerve) has many anastomoses with the trigeminus (fifth). Irritation of the facial nerve causes spasm in the facial muscles; paralysis causes the well-known picture of facial palsy. With the face at rest there is an obliteration of the nasolabial fold on the paralyzed side. The patient is no longer able to inflate the cheek, to whistle, or to shut the eye on the affected side.

Facial palsy can be readily demonstrated by the electric current. The two poles are placed at the exit of the nerve, in front of the ear, one on each side. The sound side contracts, while the affected one contracts feebly or not at all.

The auditory nerve, when irritated, gives rise to sensations of hearing; when injured, to partial or complete deafness. If, however, the fibers supplying the semicircular canals are affected, there result dizziness and interference with the sense of equilibrium.

The glossopharyngeal nerve is the nerve of taste for the posterior third of the tongue and for the glossopharyngeal arch. It transmits bitter sensations. By its paralysis this variety of gustatory function is lost.

The vagus (pneumogastric nerve) is a widely distributed nerve with many branches. It supplies the larynx, the pharynx, the heart, the lungs, the esophagus, the stomach, the intestines, and the kidneys,

Irritation of the superior laryngeal branches of the vagus nerve causes cough and laryngeal spasm. Paralysis of these branches leads to foreign body pneumonia. Irritation of the thoracic portion of the pneumogastric may—for example, in fracture of the ribs and resulting pleurisy—cause reflex cough and rapid pulse. Irritation of the abdominal portion causes vomiting.

The spinal accessory nerve has two branches, the anterior of which goes to the pneumogastric while the posterior supplies the sternomastoid and latissimus dorsi muscles. Paralysis of the posterior branch causes a drawing of the head to the other side (torticollis), and interferes with the movements of the shoulder on the affected side.

The hypoglossal nerve is the motor nerve of the tongue. When paralyzed, movements of the tongue are no longer possible.

I. CONTUSIONS OF THE HEAD.

The statements contained in the following pages are based on observation of 449 cases of injuries involving the head and face. Some of the cases were under observation for a period of twelve years. The injuries were proportioned as follows: 259 cases of contusion or contusion wounds, of which 107 were complicated by concussion of the brain; 134 cases of fracture of the skull; 76 lesions of the face. Of the 259 cases of contusion, about 50% made a perfect recovery; therefore, no insurance was allowed. Of the remaining number, which included the cases complicated by concussion of the brain and those occurring in elderly individuals, the majority were considered to be entitled to an allowance.

Slight contusions of the head, such as may be caused by kicks, blows, or striking the head in falling, are not, in the majority of cases, when healthy individuals are concerned, to be looked on as serious accidents, unless the skull is injured or there is concussion of the brain. As a rule, the accident does not keep the patient from working, and no special attention is paid to it; many cases, in fact, are not reported at all. In consequence of the rich blood-supply of the head, contusions usually lead to the formation of hematomata, which vary in size and appearance according to their location. As a rule, they call only for temporary treatment or for none at all. The hematoma may be seated in the scalp itself, in the subaponeurotic layer (where it may give rise to a mistaken diagnosis of fracture), between the pericranium and the bone, or between the bone and the dura mater. If not quickly

absorbed, it is liable to develop into a cyst or an aneurysm. Such a cyst is open to the possible danger of suppurative inflammation, which may be followed by cellulitis. A hematoma that is slowly absorbed may, in other cases, leave a hard, thickened area in the scalp or under the perieranium, which may be difficult to recognize, but which is likely to give rise to neuralgic disturbances.

Serious contusions often cause fracture of the skull or concussion of the brain, with or without definite symptoms of cerebral hemorrhage.

Crushing of the head is a more serious accident than the contusions just referred to, and may be caused in various ways. The individual may be run over, or may be caught between moving objects or under a falling wall or embankment, etc. Accidents of this nature usually cause fracture of the skull: often a compound fracture. It is a remarkable fact, however, that the head is sometimes able to bear even severe crushing without fracture or apparent serious result of any kind. Two cases of crushing of the head that were under my observation may appropriately be cited here. Both were accompanied by concussion of the brain.

The first case occurred in a workman about forty-five years of age, whose head was caught under a falling elevator. Sequel: severe hysteria. The second case occurred in a workman, twenty-four years of age, whose head was caught between the boom of a derrick and the ground. Sequel: insanity.

Cerebral hemorrhages caused by contusions of the head give rise to symptoms of compression of the brain, which will be referred to later on. If not absorbed, the hemorrhagic extravasation frequently develops into one of the cysts or tumors before mentioned. In some cases these give rise to no symptoms of importance for many years; according to some observers, periods as long as thirty years have elapsed before the symptoms of cerebral tumor became evident.

Wounds of the head occur with comparative frequency.

In the building trades and mining industry they are often the result of contusions. Wounds of the scalp bleed very freely ; the hemorrhage is best controlled, after thorough cleansing of the wound, by aseptic or antiseptic dressings and firm bandaging.

Open wounds of the scalp are very frequently the seat of infectious processes, which constitute a special source of danger in this situation because of the venous connection with the diploe and the sinuses of the cranium.

Of the infectious diseases that attack the head, erysipelas is the one with which we most often have to deal. It is easy to understand how infection occurs if we consider the carelessness and uncleanness shown by working-men in treating their wounds. Erysipelas usually runs a favorable course, but occasionally it terminates fatally.

Purulent meningitis is another complication of open wounds of the scalp. The prognosis is not unfavorable for this disease, as a rule, although death sometimes occurs in severe cases.

If the cicatrix resulting from wounds of the scalp is superficial and moves with the scalp, it gives rise to no symptoms whatever. If there are deep attachments, however, especially if reaching to the bone, serious disturbances may be caused. Compression of the nerve-branches leads to neuralgia, or even to epileptiform convulsions. Excision of the scar has effected a cure in a number of such cases. Mental diseases have been known to follow the cicatrization of wounds of the scalp ; a decided predisposition doubtless existed in all the individuals thus affected. Excision of the scar is stated to have effected a cure in these cases also.

2. FRACTURES OF THE SKULL.

Of the 114 cases of fracture of the skull serving as a basis for this section, there was fracture of the vault in 39 cases and of the base in 25 cases. The results were as follows : 19 patients made a perfect recovery ; of capacity for self-support 14 recovered 20% or less ; 29 recovered more than 20% ; while in 50 patients complete incapacity for self-support was diagnosed. The sequels were as follows : 13 were

attacked by delirium tremens ; 6 became epileptic ; 8 became insane ; a large number were affected by functional neuroses. There were 4 deaths : one died of paralytic dementia ; two committed suicide ; one succumbed to tuberculosis.

Fractions of the vault are always due to direct violence. The theory that the internal table of the bone regularly gives way first, and that it may be fractured even in cases in which the outer table escapes, has of late been disputed, and, in my opinion, not on good grounds. It is a fact that the internal table is more extensively fractured than the external in all cases in which the violence is applied to the latter. The reverse is true also. If the internal table is first struck,—when a bullet passes through the skull in a case of suicide, for instance,—the point of exit in the external table is larger than that of entrance



Fig. 1.

in the internal table. If this statement is correct, we are justified in assuming that depressions of the skull after injury indicate a corresponding convexity of the inner surface of the inner table. Such a deformity on the internal table must necessarily affect the membranes of the brain, and through them the brain itself. Figure 1 (from Helferich's "*Atlas of Fractures and Dislocations*") depicts the condition in question.

In such a case as this compression of the part of the brain underlying the deformity is inevitable.

It would be a grave mistake, however, to look upon every depression to be found on the surface of the skull as a pathologic depression, or to consider that a depression necessarily has an injurious effect on the brain. Apart from the fact that we may be misled by the sutures, which sometimes simulate a depression, it has been shown

by X-ray photographs that depressions of the skull are more often diagnosed than is warranted by the actual frequency of their occurrence. It is also true that well-marked depressions occasionally give rise to no symptoms at all, as illustrated by the following case :

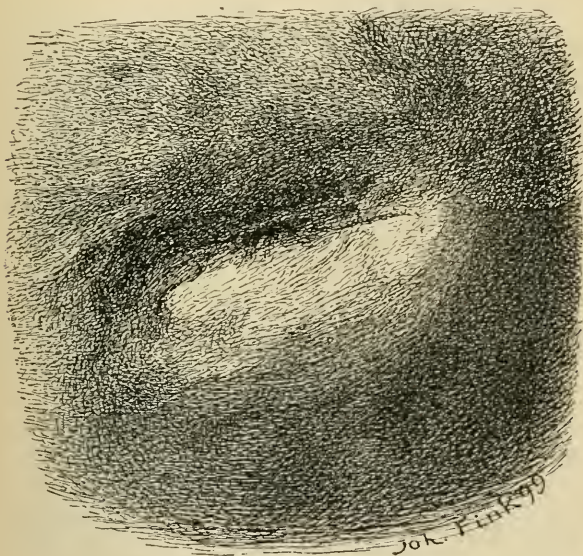


Fig. 2.

Figure 2 shows a depression of the skull, 2 cm. deep and 5 cm. long, situated at the upper part of the occipital bone. The subject of the illustration was a man about fifty years of age ; in his twentieth year he was struck on the head by a block of stone weighing $3\frac{1}{2}$ kilos, which fell from the fourth story of a building. He was not attended by a physician and was ill only a short time. He never developed symptoms of any importance.

Cases of this nature are, however, to be regarded as exceptions. As a rule, depressions of the skull give rise to definite symptoms, such as headache, dizziness, paralysis, epileptic convulsions, neurasthenic disturbances, etc.

PLATE 2.

FIG. 1.—Circular Depression and Scar in the Middle of the Forehead Following a Compound Fracture. A carpenter, fifty-four years of age, injured on the 20th of March, 1889, by the fall of a block of building-stone from a height of about fifty feet. He was unconscious for four days.

Subsequent Symptoms.—Vertigo and pain in the scar. Complete incapacity for self-support up to the 16th of June, 1891; from that date up to February 19, 1894, 50%; from that date up to the beginning of 1896, 20%; from that time on counted as fully capable of self-support, as he did not appear again for examination. Was a heavy drinker.

FIG. 2.—Deep Scar and Opening in the Left Frontal Bone Following a Comminuted Fracture. A mason, thirty-one years of age, was injured on the 24th of October, 1894, by a blow on the forehead from a hammer (assault).

Diagnosis.—Compound comminuted fracture of the frontal bone and severe concussion of the brain. The splinters of bone were removed in the hospital.

Symptoms.—At first, dull headache; later, dizziness on movement of the head; feeling of pressure in the direction of the point of fracture on lowering the head, which prevented bending.

Signs on Examination.—Decided pulsation, slight facial paralysis on the right side, dilatation of the right pupil; pulse, 100. No nervous symptoms. Incapacity for self-support since June 12, 1895, 80%.

When there is an opening in the skull due to trephining, the pulsation of the arteries within the skull can be felt externally; vertigo on stooping and a feeling of pushing and pressure in the direction of the opening are also notable symptoms. There may be paralysis and hysteric and neurasthenic symptoms in addition.

The remaining sequels of fracture of the vault are similar to those that follow concussion, contusion, and compression of the brain and fracture of the base of the skull.

Fractures of the base of the skull occur in the great majority of cases as continuations of fractures of the vault. They are due to indirect violence, and may be caused by blows on the head, by heavy objects falling on the head, or by falls—striking on the head, the buttocks, or even on the chin or the feet. According to the law of



Fig 1.



Fig 2.

Arans, the line of fracture runs by the shortest route from the point at which the violence is applied to the base of the skull. It is, therefore, very important, in obtaining the history of the accident, carefully to note the point of external injury.

Without entering into a description of the immediate symptoms of a fracture of the skull, it will suffice to mention hemorrhages from the nose, mouth, or ear, and hematemesis as symptoms pointing to this lesion. The diagnosis becomes clear if at the same time symptoms of concussion of the brain or of localized brain-lesions make their appearance.

Fractures of the base of the skull are not necessarily accompanied by severe disturbances. Occasionally, there are so few symptoms at first that the lesion is overlooked.

This fact is illustrated by the case of a mason who, in falling from a scaffold, fractured his left radius and at the same time injured his head. There was, in addition, a hemorrhage from the left ear. He felt dazed for a time, but attributed this to the shock of his fall; his attention was mainly turned to his broken wrist. Later on he frequently complained of headache. Examination revealed left facial paralysis and a rupture of the left ear-drum, with deafness on that side.

The subjective symptoms that develop in the course of cases of fractures of the base are usually those common to all fractures of the skull. Objective symptoms may be mentioned as follows: Facial asymmetry, asymmetric position of the eyes, prominence of one eyeball, etc.; also paralysis of the cranial nerves. While the facial nerve is the one most frequently affected, paralysis of the oculomotor nerve and of the abducens, olfactory, and fourth cranial nerves is not at all uncommon. Paralysis of these nerves is not necessarily symptomatic of fracture of the base; however, it also follows fracture of the vault complicated by concussion of the brain.

The great importance of the question of involvement of the brain in all cases of injury to the head warrants a short discussion of the chief forms of injury of the brain

PLATE 3.

FIG. 1.—Stone-carrier, Thirty-nine Years of Age, Fell Backward from a Scaffold on the 16th of January, 1895.

Diagnosis.—Compound fracture of the skull (frontal bone), fracture of the nasal bone, of the right malar bone, and of the right side of the inferior maxilla, with concussion of the brain.

The patient was treated for thirteen weeks in the hospital; then attended the clinic until July 20, 1896. On that day he committed suicide by hanging.

Symptoms.—Severe headache; buzzing in the head; feeling of impending danger; dizziness on stooping even slightly; flashing of light before the eyes; dancing of letters before the eyes on reading; toothache, especially during mastication. In the illustration the patient wears an expression of melancholy. A shallow depression is noticeable on the left side of the forehead, or, rather, on the temple. The right eye, the pupil of which is dilated, has a somewhat fixed gaze; the angle of the right inferior maxilla is distinctly thickened. The right eyebrow is higher than the left. The right nasolabial fold has disappeared. The scars on the right side of the forehead and nose are still red.

FIG. 2.—Case of Left Facial Paralysis with Atrophy of the Left Side of the Face Following Fracture of the Base of the Skull. The face is somewhat asymmetric and the left eyeball is slightly prominent.

A painter, twenty-five years of age, fell from a ladder on the 18th of June, 1889, at a height of about twenty-one feet, striking on the back of his head. For six days he was unconscious, and was treated in the hospital for eight weeks. For the first sixty hours there was a hemorrhage from the left nostril and the left ear, and exophthalmos on the left side. After consciousness returned a strong tendency to somnolence persisted. After leaving the hospital the patient was treated by massage and faradization of the left side of the face, as a result of which the exophthalmos and facial paralysis were much improved. The left eye could be closed at the end of three months.

Remote Symptoms.—*Objective:* Facial asymmetry, atrophy of the left side of the face, slight left exophthalmos. Constant spasmodic contractions of the muscles of the left side of the face; cicatrix in the left ear-drum. *Subjective:* Headache, sudden attacks of vertigo, especially brought on by the entrance of foreign bodies into the left eye, and accompanied by the tendency to throw the head downward and to the right; buzzing and ringing in the head and deafness. Later developments were: Unsteadiness of gait in the dark when in a strange place; inability to lie on the left ear; increase of buzzing in the head; disturbed sleep; and frequent attacks of conjunctivitis. Otherwise, the general health was good. Incapacity for self-support during time of treatment was reckoned at 100%; five months after the accident, at 45%; and later on, after resuming his trade, at 20%.



Fig. 1.



Fig. 2.

observed in connection with fractures. They are three in number: Concussion of the brain (*commotio cerebri*), compression of the brain, and contusion of the brain.

1. Concussion of the brain (*commotio cerebri*) occurs as one of the most prominent symptoms of fracture of the skull as well as of simple contusions of the head. For a description of the immediate symptoms of concussion reference should be made to text-books of surgery. Of these symptoms, unconsciousness is one of the most important, implying, as it does, involvement of the cerebral cortex. It is accompanied by disturbances of respiration and of cardiac action, due to involvement of the medulla oblongata. The face is pale, the pupils scarcely react at all; the pulse is slow and is so small and thready as to be hardly perceptible. This condition is soon relieved in mild cases, but in severe cases it persists for some time, and is further accompanied by vomiting and by involuntary passage of urine and feces.

Loss of memory (*amnesia*) is, in some cases, one of the most characteristic and important symptoms of the later stages of the disorder. Patients thus affected are likely to be unable to recall the occurrences immediately preceding the accident. Many patients, on the other hand, complain only of weakness of memory; they are unable to remember orders, especially if somewhat complicated. Other subjective symptoms are: headache, vertigo (most marked on stooping, bending forward, or looking upward), insomnia, restlessness, etc. As objective symptoms loss or weakness of memory, attacks of dizziness (*Romberg's sign*), symptoms of functional neurosis, and even paralysis of cranial or peripheral nerves may occur.

Simulation is often attempted after concussion of the brain, as, indeed, after all kinds of injury to the head, even of the simplest nature. It is often very difficult to distinguish between simulation and the unconscious tendency toward exaggeration characteristic of neurasthenic and hysteric patients.

Epilepsy occasionally occurs as a sequel to concussion of the brain—usually, it is true, in individuals in whom a strong hereditary nervous predisposition exists. It also occurs in alcoholic subjects and in those who previously have suffered from syphilis. Of my 449 cases of injury to the head, 6 were followed by epilepsy. (For further reference to epilepsy see p. 114.)

Mental diseases must also be included among the sequels of concussion of the brain; they may be manifested immediately after the accident (primary traumatic insanity) or, more frequently, in a later stage of the lesion. According to Stolper's observations, mental diseases occurred twelve times in a total of 981 injuries to the head, or in 1.22 % of the cases. The percentage in my own group of cases is exactly the same. Mental disease, however, may develop in consequence of injuries other than those involving the head. It may follow peripheral injury, or, more especially in predisposed individuals, insanity may be the outcome of intense and long-continued excitement or of severe and constant neuralgic pain.

2. Compression of the brain may be caused by cerebral hemorrhage, usually due to laceration of the middle meningeal artery; or, less frequently, it may be the result of pressure from a fractured bone. Compression often occurs in combination with concussion. In respect to symptoms, a slow pulse, due to irritation of the pneumogastric nerve, is especially characteristic. In addition, the face is flushed,—in contradistinction to the pallor seen in cases of concussion,—the eyes are bright, and the pupils contracted. The patient is conscious and restless at first; this condition is followed by one of depression. The patient becomes unconscious, with rapid pulse, dilated pupils, and irregular respiration. There may be paralysis and involuntary passage of urine and feces. In fatal cases death soon ensues; otherwise the symptoms begin to abate in severity. The sequels are in part similar to those of concussion of the brain; in part they are dependent on the manner of absorption of the hemorrhage.

Compression due to depressed fracture is occasionally followed by cortical epilepsy, as shown by the following case :

A workman, thirty-two years of age, was caught under a falling wall, and suffered, among other injuries, a fracture of the occipital bone. After healing a deep depression was left in the bone, which was much thickened at the point of fracture. About eighteen months later the patient developed epileptic attacks and mental disturbances. He is often obliged to enter an insane asylum for treatment.

3. Contusion of the brain may be caused by a sudden depression of the bone, which may resume its normal shape immediately after the injury, or by the penetration of a splinter of bone into the brain-substance in cases of fracture. Since the lesions thus caused are in almost all cases distinctly localized and limited, the symptoms, of course, correspond, being characteristic of cortical lesions entailing a loss of certain specific functions. (Compare Plate 1, with remarks.)

The subjective symptoms to be observed in the later stages of the affection are similar to those of concussion of the brain and of functional neuroses—headache, vertigo, weakness of memory, etc. The objective symptoms, also, may resemble those of the functional neuroses or those due to diseases of the brain involving anatomic changes in the latter.

The lesions of the cerebellum deserve special consideration ; of the symptoms to which they give rise ataxia is the most prominent.

Thiem mentions the following symptoms : (1) Occipital pain, with stiffness of the neck. (2) Vertigo ; unsteady movements in arising. (3) Nausea and vomiting.

Among other sequels of injury to the brain, two call for discussion here : (1) Diabetes, (2) apoplexy.

Diabetes may follow injuries to the head as well as mental excitement or severe physical shock (as in railway accidents, for instance).

The symptoms are loss of flesh, furunculosis, sexual im-

PLATE 4.

FIG. 1.—Case of Severe Comminuted Fracture of the Skull. Examination reveals ptosis and internal strabismus. The patient is markedly deficient in intelligence; shows criminal tendencies; has been imprisoned a number of times. The stupid expression of the face is very apparent.

FIG. 1 a.—Showing Cicatrix of Figure 1. The pulsation of the vessels is clearly perceptible through the opening in the bone.

A workman, twenty-three years of age, was injured by being struck on the head by a piece of iron. Was in hospital for two months. Began to work in three months, but was compelled to stop on account of headache. Entered hospital again and was trephined.

Later Symptoms.—Headache, vertigo, frequent spasmodic contractions of the muscles of the calf, epileptic convulsions. On stooping, feels pain, running from the back of the head to the forehead. Memory is weak.

FIG. 2.—Cicatrix, with Long and Rather Deep Depression in the Bone, Located on the Left Side of the Skull. The cicatrix commences at about the upper angle of the occipital bone.

A. M., stone-carrier, thirty-three years of age, was struck on the head on the 13th of April, 1887, by a building-stone that fell from the fourth story. The lesion was a compound fracture of the skull causing paralysis of both the upper and lower right extremities. After removal of a piece of the bone the paralysis was relieved, except as to the fourth and fifth fingers, in which muscular weakness and a feeling of numbness persisted for a considerable period. A slight weakness also remained in the foot. The patient was a heavy drinker. At first his incapacity for self-support was reckoned at 100%; on the 18th of November, 1888, it was 33 $\frac{1}{3}$ %; on the 29th of December, 1889, his capacity for self-support was fully reestablished. About one year later epilepsy developed, accompanied by mental disturbances. Frequent institutional treatment was necessitated. Incapacity, 100%.

potence, etc. The symptoms do not differ in the least from those of diabetes of nontraumatic origin.

Apoplexy may be directly caused by traumatism of the head, especially when there is concussion of the brain. In the great majority of cases, however, apoplexy can not rank as an accident. The individual attacked by apoplexy falls suddenly, and in so doing suffers an injury of the head on account of which insurance can be recovered. Such an injury may make it very difficult to decide whether the apoplexy is the result of the fall or vice versa.



Fig. 1.



Fig 1^a



Fig 2.

The **treatment** of injuries of the head must necessarily be symptomatic. Psychoses demand general treatment ; drugs will nevertheless be frequently found necessary. For headache the bromids, antipyrin, phenacetin, and salicylic acid can be employed ; for neuralgic pain, morphin ; for insomnia, sulphonal will prove useful, etc. Galvanization of the head (anode, one or two milliamperes, for about one minute) or the use of static electricity is often followed by good results. The same may be said of hydrotherapy. Medicomechanical exercises have an excellent effect on digestion, sleep, mental condition, and the general health. A stay in the country is very beneficial. It is advisable to settle the matter of insurance-rate as soon as possible.

The length of time required for **after-treatment** depends largely on the age of the patient ; as a rule, young persons recover much sooner than older patients. As far as my own cases are concerned, the younger individuals were able to return to work in from four to six weeks, while at least as many months were required for elderly patients. It is also a fact that elderly patients are very unwilling to resume work, and some never do so at all, while young people usually take up their trade again very soon.

3. TRAUMATIC DISEASES OF THE BRAIN AND ITS MENINGES.

Inflammation of the Dura Mater ; Pachymeningitis.—The lesion in pachymeningitis consists of a membranous thickening of the dura. This thickening is liable to be the seat of interstitial hemorrhages ; it may involve either the external or the internal surface of the dura. It is stated that pachymeningitis is the form more frequently observed ; both forms occur usually in connection with other diseases of the brain and its meninges, rather than as separate diseases. Pachymeningitis may be caused by traumatism—by contusions or fractures of the skull, for instance—complicated by hemorrhagic extravasation be-

tween the bone and the dura or between the two layers of the dura itself. Pachymeningitis is often observed as an accompaniment of paralytic dementia, but the cause most frequently underlying the disease is chronic alcoholism.

The **symptoms** are apt to be overshadowed by those of the disease of the brain with which the pachymeningitis is connected. They consist of headache, vertigo, unilateral epileptic spasms, paralyses, optic neuritis, and fever. In chronic cases the chief symptoms are continuous dull headache, vertigo, and mental depression.

The **treatment** is symptomatic; ice-bags, blood-letting, and the use of bromids may be mentioned.

Incapacity for self-support, from 50 to 100 %.

Illustrative Case.—A stone-carrier, forty-five years of age, fell from a ladder on July 20, 1888, striking his head against an iron beam. Lesion: compound fracture of the frontal bone. On October 16, 1888, I made an examination and found the cicatrix attached to the frontal bone. The patient complained of severe headache and of dizziness. In view of the fact that he was a subject of chronic alcoholism, I made a diagnosis of pachymeningitis. His incapacity for self-support was 50 %.

4. TRAUMATIC INFLAMMATIONS OF THE PIA MATER.

Leptomeningitis.—Leptomeningitis usually takes the form of a diffuse suppurative inflammation, following infection through the wound of a compound fracture, or excited by extension from an erysipelas of the scalp of traumatic origin.

Symptoms.—Headache, partial loss of consciousness, delirium, somnolence, vertigo, hyperesthesia, vomiting, fever, rigidity of the muscles of the neck, disorders of the cranial nerves (optic and facial nerves), loss of pupillary reflex, inequality of the pupils, ptosis, and strabismus.

Tubercular basilar meningitis of metastatic origin may also develop after traumatism of the head. Its **symptoms** are headache, vomiting, delirium, convulsions, fever, somnolence, rigidity of the muscles of the neck, aphasia, and paralyses.

Hemorrhage of the brain is caused by the rupture of a cerebral artery; the middle cerebral artery is the one most subject to this accident. As a rule, rupture occurs in arteries affected by arterial sclerosis or at the seat of a small aneurysm. Cerebral hemorrhage is, therefore, most frequently observed in cases of chronic alcoholism or chronic lead-poisoning. (Compare with apoplexy.)

Causes.—Severe muscular strain, mental excitement, fright, acute alcoholism, and, occasionally, traumatism.

The **symptoms** are similar to those of apoplexy.

5. ABSCESS OF THE BRAIN.

This lesion may follow an injury to the skull or it may be secondary to another infectious process, such as purulent meningitis, caries, etc. The abscess may be located directly under the injured spot, forming a superficial cortical abscess, or the pus may become encapsulated, causing no symptoms for many years. Even ten or twenty years may elapse, and the injury may be quite forgotten, when suddenly there is a violent outbreak.

[It should not be forgotten that cerebral abscess may be the direct result of scalp wounds that had been regarded as insignificant or had been overlooked altogether. It frequently follows pistol-shot wounds.—ED.]

Symptoms.—Localized cortical symptoms, paralyses, dull headache, vomiting, vertigo, fever, convulsions, etc.

6. TUMOR OF THE BRAIN.

Tumors of the brain, originating in the bone, meninges, blood-vessels, or substance of the brain itself, may develop in consequence of traumatism; gliomata, gummata, and sarcomata are the varieties most frequently observed. The growth of a glioma may cover a period of many years—in one case on record a period of thirty years, dating from the time of accident. (See Adler, "Arch. f. Unfallheilk.," vol. II, 1898.)

[The relationship between traumatism and the development of tumors in the nervous system is so difficult of demonstration that unless the time-interval between the receipt of the injury and the first appearance of symptoms is reasonably short, the causal connection between the two is little more than conjectural.—ED.]

Symptoms.—Headache, central vomiting, vertigo, dullness, somnolence, slow pulse, apoplectiform and epileptiform attacks, optic neuritis, and focal symptoms. The localized symptoms vary with the site of the tumor.

Treatment.—Symptomatic; possibly trephining and removal of the tumor.

7. PROGRESSIVE PARALYSIS, DEMENTIA PARALYTICA.

Traumatism (injuries of the head, fractures of the skull) may be followed by a process of degeneration in the brain, to which the foregoing name has been given. The signs of cerebral degeneration may become apparent very soon after the injury or not until considerably later. Imbecility, syphilis, and chronic alcoholism all act as predisposing factors. In predisposed individuals paralytic dementia may also develop after peripheral injuries as the sequel of a traumatic neurosis.

[The editor has made a study of the reports of cases of alleged traumatic general paresis and of a number of personally observed cases of the disease in which trauma figured prominently in the history given by the patient or his friends. ("Accident and Injury: Their Relations to Diseases of the Nervous System." By Pearce Bailey, M.D. D. Appleton & Co., 1898.) From this study the conclusion seems unavoidable that if trauma is ever the sole cause of general paresis, such a causal relationship is extremely unusual and difficult of proof, and is to be accepted only after scrupulous inquiry has eliminated the many opportunities for error. General paresis is a disease characterized by an excitable and inattentive mental state

which exposes the victim to all kinds of physical injury, so that an injury that is advanced as a cause may well be one of the results. Furthermore, the onset of the disease is so insidious that it is practically impossible to tell when it begins. If all these facts are considered, few physicians would care to go further, in any given case, than to say that the injury stood in a direct causal relationship with the brain-disease.—ED.]

Symptoms.—Changes in the character; changes in and diminution of mental ability, memory, and power of speech; a tendency to excesses; inequality of the pupils and loss of pupillary reflex; paralytic disturbances of speech; loss of the patellar reflex; tremor of hands and tongue; paralytic attacks; delusions, etc.

Illustrative Cases.—1. A workman, forty-three years of age, became unconscious after falling from a ladder, but soon regained consciousness. He visited a dispensary, where he received treatment for an injury of the thumb. One year after the injury he began to suffer from frequent attacks of headache, increasing in severity. Six months later he developed acute mania and was placed in an insane asylum. Diagnosis: *progressive paralysis*.

2. A roofer, thirty-one years of age, fell about fifteen feet, striking on his feet and suffering a compound fracture of the left ankle. Recovery was very protracted. Two years later he consented to the amputation of his foot. As he was unable to pursue his trade, he worked at odd jobs. Four years after the accident a diagnosis was made of dementia paralytica. His death occurred six years later. The connection between the accident and the mental disease was recognized in this case.

8. FUNCTIONAL NEUROSES.

Traumatic Neurosis (Oppenheim), Neurasthenia, Hysteria, and Hypochondriasis.

Since the passage of the laws relative to accident-insurance, *functional neuroses* have been the subject of widespread interest. The publication of the work of Oppenheim on "Traumatic Neuroses" was the signal for the expression of all sorts of opinions on functional neuroses, which, far from casting light on the subject, succeeded in

confusing the minds of inexperienced physicians, in creating dissension in trades-unions, and in doing real harm to the sufferers from accidents, who were led to believe themselves entitled to insurance or afflicted with imaginary symptoms. The belief that traumatic neuroses were incurable, and that they led to complete and permanent incapacity for self-support, had a very injurious effect on all interested persons. The general confusion of ideas on the subject has been further heightened by the mistake, committed by many physicians, of making a diagnosis of traumatic neurosis in cases not exhibiting the slightest sign of neurosis, such as internal organic diseases accompanied by fever and delirium, and in various diseases in which the diagnosis was questionable. The uninitiated soon came to believe that in traumatic neurosis a new, severe, and incurable nervous disease had been discovered. The term "accident-neurosis" may have arisen in this manner.

Oppenheim gained a large number of adherents at first, among them physicians of prominence. Vigorous opposition was made, on the contrary, to the acceptance of the symptom-complex described by him as characteristic of traumatic neuroses. It was said by some of his opponents, physicians of high standing, that this symptom-complex represented no new disease; that the symptoms he described were those of neurasthenia, hysteria, or hypochondriasis, or combination-forms of these diseases. Further, that it was both unnecessary and undesirable to invent a new name, as it would only give rise to incorrect ideas regarding the nature and significance of functional neuroses. This point of view has now come to be generally accepted as correct. Whenever, therefore, the term "traumatic neurosis" appears in the text, it is intended to describe one of the functional neuroses known to us under the name of neurasthenia, hysteria, or hypochondriasis, which has developed under the influence of traumatism.

We must bear clearly in mind the generally accepted definition of functional neuroses: namely, that they are affections of the nervous system not dependent upon any demonstrated anatomic changes, but recognized by the changes in functional power by which they are characterized. According to this definition, we must exclude all diseases of the nervous system that, by reason of the nature of the injury and of the symptoms exhibited, seem clearly to involve anatomic changes in the nervous tissue.

[The terms "functional" and "organic," while indispensable for clinical purposes, rest on an uncertain foundation. Pathologic inquiry is constantly revealing a material basis for disorders previously regarded as functional. It is extremely probable that, in many of the cases that are put in the rubric of "traumatic neurosis," the symptoms following severe traumatisms are due to such demonstrable lesions in the central nervous system as capillary hemorrhages, small foci of softening, etc., with their sequels. But until this probability receives more positive demonstration than it has as yet obtained, such cases must continue to be called "functional" or, at best, "unclassified."—ED.]

It is worthy of note, too, that functional neuroses do not develop as a result of traumatism except in predisposed individuals—subjects of a nervous heredity, alcoholism, etc. For while "strong natures are able to withstand mental shock without wavering, weak natures succumb to physical or psychic traumatism."

[This statement requires qualification, for in the experience of the editor, cases of severe functional nervous disturbances following fright or slight injuries develop when there is absolutely no predisposition demonstrable, either in the patient himself or in his ancestral history. This is true of both hysteria and neurasthenia.—ED.]

Working-men are exposed to the influence of a number of predisposing and accidental factors favorable to the development of functional neuroses, such as hereditary

tendencies to nervous diseases, alcoholism, or epilepsy; imperfect mental and physical development; unsanitary housing; poor and insufficient food; worry and care; alcoholic excesses, etc.

(a) **Neurasthenia.**

[Neurasthenia induced by injury or fright has an eventful pathologic history. It is the "railway spine" of Erichsen, the "railway brain" of later writers, and even to-day is called by these or similarly indefinite terms. With the exception of an unusual prominence of the complaint of pain in the back, and of morbid fevers referable to the accident, its symptomatology is practically the same as that of neurasthenia due to causes other than injury. It is a very frequent source of litigation in personal-injury claims in this country. When the symptoms are pronounced and persistent, it is a disabling affection. In the majority of cases, however, the patient is eventually able to resume his occupation.—ED.]

This term designates a condition of morbid weakness and irritability of the psychic and physical activities. A neurasthenic is able to begin physical tasks with energy, but soon tires, and in consequence comes to imagine that he is actually ill.

The **symptoms** are as follows: Changes in disposition; irritability; diminution of will-power and of power of work; lack of power of concentration; absent-mindedness; fatigue on slight exertion; morbid self-observation; headache; sense of pressure in the head; tremor; flashing before the eyes; frequent attacks of insomnia; dreams of an unpleasant and exciting nature; palpitation of the heart; pains of various kinds; imperative conceptions; etc.

Objective symptoms, such as paresthesias and exaggerated reflexes, are often present, but not necessarily so.

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(b) Hypochondriasis.

In this affection the imagination and self-observation of the patient are more concentrated on one special point. While a neurasthenic complains first of one ailment and then of another, sometimes feels better, sometimes worse, and desires to talk about his condition, a hypochondriac clings firmly to his special form of complaint, and broods over it in silence. A belief in abdominal disorders is especially characteristic of hypochondriasis.

A Case of Traumatic Neurosis Following Fracture of the Skull and Concussion of the Brain.—A stone-carrier, thirty-seven years of age, was hit on the head by a long board that fell from the second story. The accident happened on the 26th of November, 1888. He was first treated by his lodge doctor, then in the hospital. He resumed work for a short period, but was obliged to discontinue it on account of headache and to reenter the hospital, where he was treated for *abscess of the brain*. I examined the patient on the 25th of February, 1889, and noted the following symptoms: Headache; attacks of vertigo; flashing before the eyes; disturbed sleep; tremor; unsteady gait, more apparent in the house than on the street. The patient looked well nourished and in good health. He was afterward examined by various alienists, and declared by some to be guilty of simulation; after much effort, however, he obtained an allowance based on 50 % incapacity for self-support.

(c) Hysteria.

[Of all diseases for which compensation is sought at law, none is subject to such gross misconception as traumatic hysteria. It has a well-established and characteristic symptomatology, yet it seldom is recognized by physicians generally in this country. It is essentially a mental disease, but since its most striking manifestations are physical (*e. g.*, paralysis, blindness, loss of sensibility, contracture, etc.), the patient has the appearance of a badly crippled man rather than of a person suffering from perverted psychic functions. The result is that ignorant or corrupt experts, and juries, formulate their opinions on the appearance of the plaintiff, without stopping to inquire as to the

true nature of the disorder. As a consequence, excessive verdicts are rendered the plaintiff, on the hypothesis that the injuries are incurable and permanent. Now, it can not be denied that as a result of improper treatment or of unfortunate environment traumatic hysteria may become an extremely rebellious affection ; but it should be admitted, with equal candor, that the psychosis is essentially curable in its nature, and that the majority of the patients, with time and proper care, get well ; and that verdicts rendered on the hypothesis that the plaintiff is ruined for life are unjust in the extreme. This subject deserves more attention than it receives. The disease comes frequently to the notice of physicians who have to deal with disorders of the nervous system following accidents, and it is particularly liable to lead to litigation.—ED.]

The term hysteria denotes a condition dependent upon *morbid mental conceptions*. If a hysteric patient dreams, for instance, that he has been run over, he believes on awakening that the accident has really occurred. The disease is, therefore, of a *psychic* nature, the morbid conceptions on which it is grounded being called forth by suggestion. These conceptions give rise to innumerable functional anomalies, both motor and sensory, which are not based, so far as can be ascertained, on any organic changes. Hysteric patients are very susceptible to suggestion and to autosuggestion. New ideas and conceptions are, therefore, very readily awakened in them, and they are easily influenced by strangers. Their decisions are not to be counted on ; their attitude toward their associates is capricious ; they are moody, irritable, absent-minded, and likely to act on impulse.

The physical symptoms of the disease may be (1) permanent (stigmata) or (2) periodic (hysteric attacks).

To the first class belong :

1. *Hemianesthesia*, complete loss of ordinary sensation of one half of the body ; possibly also insensibility to pain. The sense of taste, of smell, and of hearing may be abol-

ished on the affected side ; there may be partial color-blindness and retraction of the visual field.

2. *Hyperesthesia*.—This may affect all of one side of the body or only parts of the same. Hysterie attacks may be brought on by pressure on the hyperæsthetic areas. Various morbid sensations also belong to this class, such as the *globus hystericus*, for instance.

3. *Hysterie paralyses*, which may disappear as suddenly as they develop.

4. *Hysterie Contractures*.—*Hysterie convulsive attacks* are manifestations of central irritation, exhibiting the most varying forms and combinations of forms. The attacks consist of clonic and tonic spasms of the extremities and the face, the latter being distorted by grimaces, while the patient alternately laughs and weeps, and assumes strange postures. Hallucinations frequently accompany the attacks. Hysterie convulsions differ from those of true epilepsy in not being accompanied by the deep coma characteristic of the latter disease. In hysteria consciousness is invariably retained, and the reflexes are not affected ; the patients usually fall with the least possible injury to themselves, while epileptics fall face downward. Hysterie patients, furthermore, can be aroused from a convulsive attack by gentle shaking and by sprinkling with cold water.

The **treatment** of hysteria should chiefly be directed toward the removal of all influences calculated to encourage the morbid feelings of the patient. Work is usually the best therapeutic agent for a hysterie or neurasthenic workman, and, for this reason, in estimating the insurance allowance it is advisable to avoid a high rate, whenever feasible, in order to compel the patient to work. A high rate of insurance encourages the patient to believe himself to be seriously ill, whereas if he is obliged to go to work, his morbid conception will be overcome, and his recovery will ensue. It is characteristic of accident-neuroses that the mind of the patient is almost altogether occupied with

questions relating to the accident and all that appertains to it, and to the *rate of insurance* to be allowed.

Epilepsy not infrequently develops as a sequel of injuries of the head, especially in cases of depressed fracture entailing irritation of the *brain-cortex* by reason of a thickening of the bone, a cicatrix in the meninges, or an inflammatory process. It is also observed as a result of the cicatrization of wounds of the scalp.

A typical epileptic attack is inaugurated by an *aura* (headache, vertigo, nausea, general discomfort, etc.). In addition to the convulsions, which are both clonic and tonic in nature, the attack is characterized by the following symptoms: unconsciousness, loss of reflexes, foaming at the mouth, biting the tongue, and clenched fists. After the attack passes off the patient feels dazed, nauseated, depressed, and generally unwell. This condition may persist for some time. Of the attack itself the patient has no remembrance whatever.

Epilepsy can in some cases be cured by trephining and by removing the irritating cause. Predisposition plays no less important a part in the etiology of this disease than in other nervous diseases following traumatism. An alcoholic heredity is an especially strong predisposing factor. Epileptic attacks may be brought on by peripheral injuries as well as by injuries to the head.

Illustrative Case.—A painter, twenty-nine years of age, who had frequently suffered from lead-poisoning, fell from a height of twenty-five feet on the 30th of April, 1889. Lesion: *fracture of the base of the skull with paralysis of the left arm*. The patient was treated for one month in the hospital and for another month in the dispensary. He then resumed work. On the 4th of September, 1889, he was again examined with reference to insurance, because of headache and dizziness. On the 11th of November, 1889, he felt entirely well, and resumed work. He was then considered to be *fully capable of self-support*. On the 16th of March, 1895, he *suffered an epileptic attack*, which was repeated at intervals. The connection between the accident and the epilepsy was proved, and he was allowed 100% insurance.

Injuries of the Face.

Slight *contusions* of the face heal without difficulty, unless they occur in connection with concussion of the brain or injuries to the nerves. They do not hinder the patient from working, or do so for a very short time, and they are often not reported at all.

Severe contusions, on the other hand, are likely to be associated with fractures or with concussion of the brain.



Fig. 3.

Figure 3 shows a workman, thirty-seven years of age, who suffered a *contusion of the right cheek*, as a result of a blow from the handle of a wheelbarrow that was overturned. The accident occurred on July 17, 1887. The patient developed a typical case of traumatic neurosis, according to Oppenheim; and I have, therefore, tried to show his facial expression in a photograph. Mental depression was a very prominent feature of the case. This patient was by many observers considered to be guilty of simulation, and the medical faculty of the Berlin University wrote an opinion on his case in 1891. This opinion can be found in the "Aerzt. Vereinsblatt," and also in the "A. N. d. R.-V.-A." of the first of October, 1897. (Compare with Traumatic Neuroses.)

PLATE 5.

FIG. 1.—Adherent Scar Over the Left Malar Bone, Following Contusion and a Probable Fracture. The scar is very apparent in the picture, as is also a thickening of the malar bone and a conjunctivitis, which is more marked on the left side. The left eye is seen to be watering. The patient was a workman, forty-nine years of age, who was struck on the left cheek by a board that fell from a height of about fifty feet.

Symptoms.—Pain on the left side of the face; headache; dizziness; toothache, especially during mastication; loss of the sense of smell on the left side of the nose. In examining the patient the constant lacrimation and a loud snuffling were very noticeable points.

Diagnosis.—Neuralgia of the left infra-orbital nerve. From massage the best results were obtained. Division of the nerve and loosening of the scar gave no relief. For two years the incapacity for self-support was reckoned at 50%; one year later, complete incapacity.

FIGURE 2 Represents the Narrow Entrance of the Right Nostril in the Case of Compound Fracture of the Nasal Bones Referred to in Connection with and Illustrated by Figure 4. The patient complained of difficulty in breathing, and was obliged for a long time to breathe through his mouth. Later on, the difficulty gradually disappeared. The picture was taken six years after the accident. He was receiving 10% allowance; about eighteen months later he fully recovered his capacity for self-support.

Wounds of the face are of greater importance, partly because they are especially subject to infection by erysipelas, partly because of the rich nerve-supply of the face and of the danger of injury to the same. Deep wounds may involve the facial or trigeminal nerve, and so give rise to neuralgia or paralysis. Deep cicatrices may press on underlying nerve-branches, causing painful spasms of the facial muscles and involuntary lacrimation. Injury to the ophthalmic branch of the facial nerve causes lagophthalmos (imperfect closure of the lids), as a result of which the eye is exposed to the danger of the entrance of foreign bodies.

Burns of the face caused by boiling water, freshly slaked lime, explosions of spirit or kerosene lamps or of gas-pipes, etc., are likely to lead to *extensive cicatricial growth* and consequently to *facial deformities*, which in



Fig. 1.



Fig. 2.

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themselves somewhat incapacitate the patient for self-support, especially in the case of a woman.

Fracture of the Bones of the Face.

Fracture of the nasal bones may be caused by striking the nose in falling or by blows from falling objects. The



Fig. 4.

injury results not only in external deformity, but frequently also in a narrowing of the nasal orifice. The patient complains of difficulty in breathing and is often obliged to breathe through his mouth. A thorough

PLATE 6.

A Case of Paralysis of the Sympathetic Nerve on the Left Side, with Atrophy of the Corresponding Side of the Face.—

On the affected side of the face is seen a distinct difference in coloring from that of the opposite side, which shows a healthy red; the left side is evidently atrophied, the eyelid droops slightly, and the whole side of the face is covered with a profuse sweat. The patient, who is a mason, fifty-one years of age, when passing a building was struck on the head and back by a man falling from the fourth story. This happened on December 20, 1892. For three weeks he was treated in the hospital; after that at home. I examined the patient on March 16, 1893. He was a man of middle height and strong build. In addition to the facial anomalies previously noted, there was a spastic paralysis of both lower extremities, more marked on the right side; the patellar reflexes were exaggerated on both sides; on the right side examination induced clonic spasms. The patient was unable to move his right hip-joint because of the pain caused thereby, and he walked with difficulty, with the aid of two canes. He was mentally intact. Incapacity for self-support, 100%.

examination should, however, always be made in these cases, since other factors, such as polypi, syphilitic ulcers, etc., may in reality cause the difficulty. Fracture of the nasal bones interferes with work only for the first few weeks after the accident, and in some cases work is not interrupted at all. Permanent incapacity for self-support is seldom rewarded unless a striking degree of deformity follows the injury or unless it is complicated by simultaneous injury of important neighboring parts.

Figure 4 illustrates the case of a boy of fifteen who was injured by a falling weight that caused a compound fracture of the nasal bones. Very little deformity is apparent; the chief difficulty concerned his breathing. The appearance of the right nostril is shown by figure 2, plate 5.

Fracture of the zygoma rarely occurs except in connection with fracture of the superior maxilla and other bones of the head. Among my cases there were five of fracture of the zygoma alone (without fracture of the skull). Some were caused by direct blows from falling objects, others by falls from a height. If the fracture is a comminuted one, it is regularly complicated by lesion of the infra-



orbital nerve or of a branch of the facial nerve. When the former is involved, the patient is likely to become a sufferer from *tic douloureux*, as a result of which he may at times be completely incapacitated for work. In some cases spasms of the facial muscles may be observed years after the accident; these are likely to cause more or less pain, but may be quite painless.

In respect to treatment, some benefit can usually be derived from warm, moist compresses, Priessnitz bandages, careful massage along the course of the painful nerves, and weak galvanism. If the pain is intense, morphin, antipyrin, and similar remedies should be administered.

The degree of incapacity for self-support is usually proportionate to the pain; in severe cases the patient may be totally unfitted for work.

Fracture of the Superior Maxilla.

This lesion occurs alone only in rare instances, but it is often observed in connection with fractures of the nasal bones and zygomatic arches, as well as with fractures of the skull in general.

In carpenters and drivers, among others, we frequently meet with compound fractures involving both the malar bone and the superior maxilla. In the one case the injury is due to blows from falling objects, and in the other to kicks from horses, etc. Subjective symptoms are toothache, headache, pain on mastication, and distress from loose teeth. Objectively, we often find loose teeth and changes in the shape of the broken jaw, but more particularly in the alveolar process. The lesion itself does not unfit the patient for work, but the pain to which it gives rise may do so.

Fracture of the Inferior Maxilla.

The under jaw is frequently fractured either alone, by falls or kicks, or as an accompaniment of fractures of the skull caused by falls from a height, cavings-in, etc. In

PLATE 7.

Contracture of the Left Trapezius in Consequence of Severe Contusions of the Left Side of the Head and Body.—Sequel, hysteria. Complete incapacity for self-support, partly due to complications.

A painter, thirty-eight years of age, fell backward from a scaffolding about fifty feet high on April 30, 1889. Lesions: severe contusions of the left side of the body, complicated by fracture of the ribs and injury of the lung; contusion of the left scapula and of the left side of the head, complicated by concussion of the brain.

He remained in hospital over three months. The illustration shows a peculiar position of the left shoulder, the head, and the left arm; also some swollen veins on the left side of the chest and left arm. He received 100 % insurance allowance, based on his pleuritic disturbances as well as the muscular contracture. He has been suspected of simulation, as he is said to assume a more normal position at times.

such instances the fracture is due to direct violence; it may, however, occur as the result of indirect violence, as in cases of violent compression of the head, or when, as occasionally happens, the coronoid process is torn off by violent contraction of the temporal muscle. There were ten cases of fracture of the inferior maxilla among the cases in my list, all of them isolated lesions, caused by falls from a height, and all, so far as could be ascertained, due to direct violence. The injury is liable to be followed by vertical or lateral displacement of the fractured parts of the bone. The displacement may be apparent externally, but can best be determined by examining the line of the teeth. In mastication or on opening the mouth the deformity is often unpleasantly noticeable.

Pseudo-arthroses in this situation interfere very decidedly with the action of the jaw, especially in mastication. All motion of the jaw is painful, and the muscles of the affected side become markedly atrophic.

Dislocation of the Inferior Maxilla.

This lesion is very rarely seen in accident-practice.

In one case that came under my observation the patient, a carpenter, thirty-seven years of age, had fallen backward from a scaffolding. The under jaw, which was dislocated, was set immediately after the accident, and a perfect recovery resulted.



Fig 1



Fig 1^a



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Injuries and Traumatic Diseases of the Neck.

Injuries of the anterior portion of the neck are very seldom seen alone; they usually occur in connection with injuries of the head and face or together with a fracture or dislocation of the clavicle. Direct injuries of the neck may be caused by explosions, most frequently in the course of mining or building operations to which blasting is incidental. Burns of the neck are frequently caused by the explosion of alcohol or kerosene lamps, and may lead to contractures causing wry-neck. Severe injuries of the neck involve great danger to the important structures and organs that it contains, often entailing grave consequences—a fact easily understood if we remember the anatomy of the part.

The muscles most subject to morbid changes after traumatism of the neck are the sternocleidomastoid and the trapezius. Contractures of these muscles produce wry-neck (*caput obstipum*).

II. THE BODY.

THE VERTEBRAL COLUMN.

Anatomicophysiology Considerations.—The vertebral column has the function, among others, of supporting the weight of the body and preserving its balance, and, in accordance with this function, it presents certain normal curves. If we look at a living human being from behind, we note that the upper dorsal region of the spine appears convex, while the cervical, lower dorsal, and lumbar regions appear concave. Departures from these normal curves occur among industrial workers as the result of special work to the requirements of which the spine has adapted itself. This is especially the case if the work in question entails a one-sided activity. The vertebral column of a stone-carrier serves as an instance of such changes; the cervical region is likely to be markedly convex posteriorly, the upper dorsal region is kyphoscoliotic, while in the lower dorsal and lumbar regions lordosis is apparent. The position of the scapulæ and arms, of the pelvis and lower extremities, is, moreover, secondarily affected, with the apparent effect of shortening some parts and of lengthening others. A certain degree of deformity of the thorax is a necessary

sequel of the other anomalies enumerated. These anomalies are well known under the name of "burden-deformities." They increase gradually and in exact proportion to the effect on the body of the weight it has to support.

The ability of the spine to support external burdens, as well as the weight of the body, while preserving the balance of the latter, is a proof of its elasticity. The elasticity depends chiefly on the presence of the spongy substance in the bodies of the vertebræ and upon the intervertebral cartilages, the other ligaments connecting the vertebræ acting as contributory factors. By reason of this attribute, the spine is able to adapt itself to compression as well as to stretching. It is compressed, and thereby shortened, by carrying heavy weights, and is lengthened by suspension of the body, while compression and stretching both occur constantly as the result of ordinary movements of flexion and extension of the body.

The following movements are normal to the vertebral column: (1) Anteflexion and retroflexion; (2) lateral flexion and oblique flexion; (3) rotation.

Extreme degrees of mobility are demonstrated by contortionists (india-rubber men). Leaving such unusual degrees of elasticity out of consideration, we find the flexibility of the spine to be in part determined by the dimensions of the intervertebral cartilages and the thickness of the bodies of the vertebræ. Thin and narrow bodies with thick and narrow cartilages favor mobility. This fact is illustrated in the cervical region, which enjoys a greater range of motion than any other region of the spine, although this is partly to be ascribed to its position in the body, in which it is peculiarly free from constraint. The lumbar region holds the second place, while the dorsal region is relatively inflexible—partly because of its costal articulations, partly because of the overlying spinous processes and the thickness of the bodies of the vertebræ. A consideration of the influence on mobility exerted by the separate articulations and ligaments would lead us too far.

In discussing the movements of the cervical region we must refer to those of the head, giving special attention to the two upper vertebræ and their anatomy. The head is not placed in a line perpendicular to the trunk, but at an angle of about 165 degrees. Neither is the neck perpendicular to either body or head. The head is held in position by the antagonistic action of the muscles attaching it to the spine and by their muscular tone. Its greatest degree of flexibility (about 80 degrees), obtained with the aid of flexion in the cervical vertebræ, does not bring it to a right angle with the body, but only to an angle of about 85 degrees (165 degrees to 80 degrees).

The head is ordinarily flexed by its own weight, aided by the rectus capitis major and minor and the longus colli muscles, the muscles of the back of the neck being relaxed. Forced flexion is produced by the action of the platysma, the scaleni antici, and probably the intertransversales. Ordinary nodding movements take place at the occipito-atloid articulation; in deep flexion the whole cervical region is called into play.

When slightly rotated posteriorly and laterally flexed, the head can be brought to an angle of from 150 to 155 degrees with the vertical axis of the trunk. In this movement the *rectus capitis lateralis*, the *intertransversales*, and the *scaleni* of one side are concerned. On the flexed side the transverse processes are approximated; on the opposite side they are separated. The oblique processes meanwhile execute a peculiar movement corresponding to the shape of their articular surfaces, which will be referred to again later. Ordinary movements of retroflexion take place, as a rule, in the occipito-atloid articulation, and are produced by the short muscles of the neck, the *rectus capitis anticus major* and *minor*, and the *superior* and *inferior oblique*. Marked degrees of retroflexion are due to the additional action of the *sternocleidomastoid*, the *splenius capitis*, the *trachelomastoid*, the *complexus* and the *biventer cervicis*, the *multifidus spinæ*, and the *interspinales*. These muscles are also called into play when the whole cervical region takes part in the movement of retroflexion, and in this case the superior fibers of the *longissimus dorsi* and the *ileo-costalis* are also involved. The movement in question can only be carried out when the muscles of both sides act in unison, unilateral action always resulting in rotation.

Rotation of the head in a vertical axis takes place in the atlo-odontoid articulation. In order to estimate the angle of rotation we must imagine two axes, a sagittal and a transverse, placed at a right angle to each other. This gives us an angle of rotation of about 75 degrees. This demands the action of the whole cervical region of the spine, and, of course, lowers the level of the axis of rotation. Ordinary rotation at the occipito-atloid articulation is produced by the action of the inferior oblique of one side—the right inferior oblique, for instance, turning the head to the right. Further degrees of rotation are due to the action of the *sternocleidomastoid* of the opposite side, causing at the same time a slight inclination of the face toward the side of the acting muscle. Rotation may call into play all the muscles of one side, which, when acting in unison with the muscles of the opposite side, produce antelexion or retroflexion of the neck.

According to H. Meyer, the spine, in executing the movement of flexion,—taking the distance between the promontory of the sacrum to the anterior tubercle of the atlas as the radius,—describes an arc of 71 degrees in an anteroposterior plane. The cervical region takes the chief part in this movement. If the radius is expressed by the distance between the promontory and the seventh cervical vertebra, the angle of flexion equals only 64 degrees, of which 31 degrees are due to the action of the three lower lumbar vertebrae. The general rule applies to the spine that the intervertebral discs are compressed during flexion on the concave side of the spine, while they are freed from pressure or stretched on its convex side. On antelexion the ligaments connecting the spinous processes—the interspinous and supraspinous ligaments, as well as the *ligamentum flava*—are subject to traction. The spinous processes are appreciably separated during this movement. At the same time the intervertebral discs undergo compression anteriorly, while posteriorly they are stretched. On flexion, the

spine was increased exactly $11\frac{1}{2}$ cm. in length in a man twenty-four years of age, the measurements including the distance from the atlas to the end of the sacrum. The muscles of the back are, of course, included in the stretching of the posterior part of the spine. During the process of anteflexion the articular processes of each vertebra glide upward on the corresponding processes of the vertebra next below it, the whole spine being at the same time slightly rotated on its transverse axis.

In executing the movement of forced anteflexion the thighs are fixed and both hips take part in the process. In young persons the angle thus formed between trunk and thighs equals about 75 degrees. On anteflexion, to which the weight of the body contributes, the abdominal muscles contract, especially the rectus and iliopsoas of each side, while the muscles of the back are stretched. Even while stretched these muscles are to a certain extent contracted, as a precaution against falling over forward. Since the spinal column is lengthened posteriorly on flexion, we may assume that it is shortened anteriorly to the same extent. The opposite condition obtains on retroflexion, the intravertebral discs being compressed posteriorly, while anteriorly they are freed from pressure. The articular processes of each vertebra glide downward on the corresponding processes of the vertebra next below, while the spine is rotated on its transverse axis in the direction opposite to that which it took on anteflexion. The last two articular processes, those of the fifth lumbar vertebra, glide down into the lumbosacral fossa of the first sacral vertebra.

Retroflexion is chiefly accomplished in the cervical region; the lumbar region takes the next chief part, while the dorsal region undergoes relatively little change; its share in the process, however, should not be underrated. In a man twenty-four years of age the cervical region, measuring from the tubercle of the atlas to the spinous process of the seventh cervical vertebra, was shortened posteriorly by 7 cm., while the dorsal and lumbar region together, measuring from the spinous process of the seventh cervical vertebra to the end of the sacrum, was shortened by only 6 cm. The total shortening, therefore, was 11 cm. Movement in the hip-joint during retroflexion is normally very slight, being greatly limited by the action of the iliofemoral ligament. The long muscles of the back contract, while the abdominal muscles, especially the rectus and iliopsoas, are stretched.

Lateral flexion, if we leave the cervical region out of consideration, is executed almost altogether in the lumbar region, or, rather, in the lumbar region and the two lowest dorsal vertebrae. Pure lateral flexion without rotation can be carried to an angle of 150 degrees without much difficulty by a man of middle age. Lateral flexion with rotation is accomplished by the action of the semispinalis dorsi and multifidus spine of one side, and can be carried to an angle of 130 degrees. The intervertebral discs are thereby compressed on the flexed side. During this movement the articular processes on the flexed side glide somewhat downward on the sides of the processes of the vertebra next above; the articular processes of the opposite side (that which is stretched) are correspondingly elevated. The conforma-

tion of the bones makes this movement necessarily a limited one. The slant of the articular surfaces of the articular processes precludes deep lateral flexion without rotation. The muscles that take part in lateral flexion are the intertransversales, and, in the dorsal region, the internal intercostals as well.

Rotation of the spine is chiefly produced by muscular action; the cervical region is most adapted to this movement, which is executed with greater difficulty in the lumbar region and is least possible in the dorsal region. The articular processes move as follows: when rotation takes place from left to right, the inferior articular processes of the left side of each vertebra are pressed against the superior articular processes of the vertebra next below.

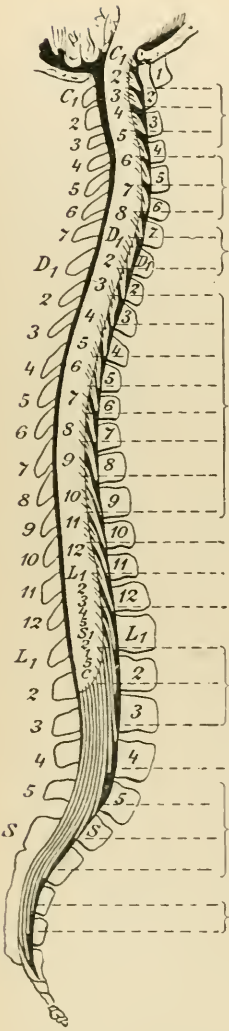
Relation of the Spinal Column to the Ribs.

The dorsal region is the least mobile of the several regions of the spine, a fact which is largely due to its connection with the ribs, especially with the first ten, which, by their articulation with the sternum in front, form the bony framework of the thorax. The ribs are connected both with the bodies of the vertebrae and with their transverse processes. The heads of the second to the ninth ribs, inclusive (sometimes of the first to the tenth, inclusive), articulate each by a double facet with two vertebrae. The ridge on the head of the rib separating the two facets lies close to the intervertebral disc, and is attached to the latter by means of a small fibrocartilaginous ligament, by which the articular cavity inside the capsular ligament is divided into two parts. The ribs also articulate with the transverse processes of the vertebrae, and, in addition, there are ligaments passing from the necks of the ribs to the transverse processes of the vertebrae.

The ribs, therefore, take part in all movements of the spine. Through their articulations with the bodies and transverse processes of the vertebrae they have a little independent action, but this is very limited. On anteflexion of the spine the ribs are separated posteriorly and approximated anteriorly; on retroflexion this process is reversed; on lateral flexion they are approximated on the side of flexion and separated on the opposite side. The sympathetic nerve passes down the posterior wall of the thorax beside the spine, in which position it is exposed to injury from fractures of the transverse processes or of the ribs near their vertebral attachments.

The interarticular ligament, as well as the other ligamentous attachments between the ribs and the vertebrae or their processes, may be lacerated as a result of forced movements of the spine. Such injuries can hardly be diagnosed during life, unless there is a dislocation of the ribs at the same points that can be discovered by aid of X-ray photographs. It is well, nevertheless, to remember their possible occurrence.

The spinous processes furnish us with the only anatomic means of determining the level of an injury of the vertebrae in a living person, or of the lesion of the cord or spinal nerves that may be consequent upon it. It is important, however, to be acquainted with the relation existing between the spinous processes, spinal nerves, and segments



Motor.	Sensory.	Reflex.
C ₁ 1	Neck and scalp.	
C ₂ 2		
C ₃ 3	Neck and shoulder	
C ₄ 4		
C ₅ 5		
C ₆ 6	Shoulder.	
C ₇ 7	Arm.	Scapular.
C ₈ 8	Hand.	
D ₁ 1		
D ₂ 2		
D ₃ 3		
D ₄ 4		
D ₅ 5		
D ₆ 6		
D ₇ 7		
D ₈ 8		
D ₉ 9		
D ₁₀ 10		
D ₁₁ 11		
D ₁₂ 12		
L ₁ 1		
L ₂ 2		
L ₃ 3		
L ₄ 4		
L ₅ 5		
S ₁ 1		
S ₂ 2		
S ₃ 3		
S ₄ 4		
S ₅ 5		

Motor.	Sensory.	Reflex.
Sternomastoid.	Neck and scalp.	
Trapezius.	Neck and shoulder	
Diaphragm.		
Serratus.		
Shoulder.	Shoulder.	
Arm-	Arm.	Scapular.
Hand-	Hand.	
(ulnar lowest).		
Intercostal muscles.	Front of thorax.	Epigastric.
	Ensiform area.	
Abdominal muscles.	Abdomen (umbilicus, tenth).	Abdominal.
	Buttock (upper part).	
Flexors of hip.	Groin and scrotum (front).	
Extensors of knee.	Thigh { outside. } front. inner side	Cremasteric. Knee-jerk.
Adductors.		
Abductors.	Leg, inner side.	
Extensors (?)	Buttock, lower part.	Gluteal.
Flexors of knee (?)	Back of thigh.	
Muscles of leg moving foot.	Leg and foot { except inner part.	Foot-clonus.
Perineal and anal muscles.	Perineum and anus.	Plantar.
	Skin from coccyx to anus.	

Fig. 5.—Diagram and table showing the approximate relation to the spinal nerves of the various motor, sensory, and reflex functions of the spinal cord.

of the spinal cord in respect to level, since they do not by any means correspond in this particular. The accompanying table, according to Gowers (Fig. 5), is a valuable guide in determining these points, as

1 2 3 S 4 5 Co	1C	3C	2C	1	C
			4C	2	
			5C	3	
		8C	6C	4	
			5		
			6		
	2D	3D	1D	7	D
			1		
	5D	6D	4D	2	
			3		
	8D		7D	4	
				5	
		10D	9D	6	
			7		
	12D	1L	11D	8	
			9		
	3L	4L	2L	10	
			11		
			5L	12	L
1					
2					

Fig. 6.

well as in settling questions of motor, sensory, and reflex functions; while the schema of Reid (Fig. 6) shows the relation between the spinous processes and segments of the cord.

I. GENERAL SYMPTOMS OF TRAUMATIC DISEASES OF THE SPINAL CORD.

In all cases of injury affecting the spinal column the question of involvement of the cord is of vital importance ; a short review of the traumatic diseases of the cord seems, therefore, in place at this juncture.

It may be said, speaking in general terms, that injuries of the cord are followed by (1) sensory disturbances and (2) motor disturbances. The sensory disturbances consist in anomalies of the tactile, muscle, or temperature senses, and of the sense of pain (anesthesia, analgesia, hyperesthesia, girdle sensation). Motor disturbances are expressed by paralysis or exaggerated muscular activity (muscular rigidity, spasms, contractures, neuropathic contractures). The various forms of clonic muscular spasms may also be included among the motor disturbances—muscle-waves, fibrillary contractions, tremor, tetany, etc.

The condition of the reflexes is an important index to the diseases of the cord. If they are normal, we can conclude that the section of the cord through which the reflex loop passes is unaffected. When, on the other hand, the reflexes are found to be exaggerated, diminished, or completely lost, we know that the part of the cord in question is diseased.

[The most important reflex is the knee-jerk. Immediately after a severe contusion to any part of the cord, the knee-jerks may be very much diminished or unobtainable. If the injury is above the lumbar region, the absence of the knee-jerk alone is not sufficient evidence for a total transverse lesion ; for with the resorption of blood, and recovery from shock to the nerve-fibers and nerve-cells, the knee-jerks, though they were absent at first, may return or may become exaggerated. If the knee-jerks have not returned by the end of a week or ten days, however, it is certain that the lesion is extensive and severe.

In lesions in the lumbar region and lower down, both

in the cord and in the nerve-plexus, the knee-jerk is less reliable as an index of the extent of the injury ; for these regions are the seats of the knee-jerk mechanism, and even partial injuries here are very likely to destroy it.—
ED.]

The reflexes are exaggerated in case of (1) increased irritability of the gray substance of the cord, as a result of inflammation or trophic disturbances ; (2) when the reflex centers in the cord are cut off from the inhibitory control of the brain.

When both these causes act together in a given case, the reflexes are exaggerated to an extreme degree. The exaggeration of reflexes due to fatigue does not, of course, belong in this category. The reflexes are diminished or lost in consequence of injury or disease of the anterior nerve-roots (motor-paralyses), or of injury or disease of the posterior nerve-roots (anesthesia), or, furthermore, in consequence of lesions of the gray substance of the cord or of the lateral pyramidal tracts. The reflexes that especially deserve attention are :

1. Cutaneous reflexes :

- (a) Plantar reflex : Contraction of the muscles of the foot on irritation of the sole. (Lower part of the lumbar enlargement.)
- (b) Gluteal reflex : Contraction of the gluteal muscles on irritation of the skin of the gluteal region (fourth and fifth lumbar segments).
- (c) Cremaster reflex : Retraction of the testicle on irritation of the skin on the inner surface of the thigh (first lumbar segment).
- (d) Abdominal reflex : Contraction of the abdominal muscles on irritation in the region of the linea alba (eleventh dorsal segment). [Babinski has recently described a previously unknown pathologic reflex. It has long been known that irritation of the sole of the foot produces flexion of the toes, especially marked in the great toe. Babinski calls

attention to the fact that in lesions of the pyramidal tract this reflex is reversed: *i e.*, irritation produces extension (dorsal flexion) in the toe. This symptom is a fairly constant and reliable one. It is specially useful in the diagnosis of hysteria from organic disease.—ED.]

2. Of the tendon-reflexes we take note of the patellar reflex, the triceps reflex, and the reflex of the tendo Achillis. Loss of the patellar reflex indicates disease of the posterior gray columns of the cord at the level of the second to fourth lumbar nerves.

The ankle-clonus is a reflex belonging only to pathologic conditions.

Incoordination is another symptom indicative of disturbance of motility. It depends upon a morbid condition of the muscle-sense, and is shown by uncertain and purposeless movements of the hands, fingers, and legs.

The gait is distinguished as paretic, ataxic, and spastic.

Other symptoms of lesions of the cord are vasomotor disturbances, evidenced by lowering of the temperature, a feeling of cold, cyanosis of the skin, edema, and sometimes necrotic ulcers.

Bed-sores are a regular accompaniment of recent injuries of the cord. As a result patients are liable to die of general sepsis in spite of every precaution.

The condition of the muscles is important. Atrophy becomes more and more marked; electric stimulation elicits the reaction of degeneration.

The internal organs affected in consequence of injuries of the cord are:

1. The bladder.
2. The intestines (meteorism).
3. The kidneys.
4. The heart is less frequently affected; irregularities in its action are, however, sometimes noticed.

Paralysis of the bladder is a common symptom in diseases of the cord. This condition leads to the retention

of urine, necessitating catheterization, or to incontinence of urine. The urine frequently contains casts, phosphates, etc. In the kidney, anemia and anemic necrosis have been observed by Wagner and Stolper. Calculi composed of phosphate and carbonate of lime have been found in the bladder.

In all cases of traumatism involving the cord it is essential to the prognosis to learn whether the lesion is partial or complete. According to Wagner and Stolper, the symptoms of total transverse lesions are as follows :

1. Motor and sensory paralysis, equally marked on both sides of the body.
2. Loss of all nervous irritability in the region affected by the paralysis.
3. Loss of the patellar reflexes.

In addition we find :

4. Paralysis of bladder and rectum.
5. Vasomotor paralysis.

Symptoms of partial lesions, according to the same authors, are :

1. Motor and sensory disturbances having an unequal distribution.

2. The two sides of the body are especially liable to be unequally affected (asymmetric paralysis).

3. There are signs of both motor and sensory irritability.

4. The patellar reflexes are present in almost all cases ; they are usually exaggerated and are often unequal as to the two sides. *They are never permanently lost.*

5. Variations in degree of both motor and sensory paralysees. The paralysees have a gradual onset and remain incomplete.

6. Partial or complete restoration of functional power takes place within one to two weeks.

The prognosis depends in part on the level at which the cord is injured. Lesions due to traumatism usually involve its transverse diameter, destroying the nerve-centers

at that level and severing or injuring the nerve-paths crossing it. It is a help in forming an opinion of a case to imagine that the cord is divided into a number of transverse sections. In examining accident-cases we find that the spinous processes of the vertebræ are useful guides, while the schemata of Gowers and Reid, together with careful observation of the symptoms, aid us further in coming to a correct conclusion as to the level of the lesion.

2. INJURIES OF THE SPINAL CORD; CONCUSSION OF THE CORD.

The actual lesion caused by this injury is unknown, the opinions usually accepted being only hypothetic. Eminent authors, like Kocher, and Wagner and Stolper, deny the occurrence, or even the possibility of the occurrence, of a concussion of the cord. It can not be disputed that all the symptoms that are attributed to concussion may just as well be due to hemorrhage into the substance of the cord or its meninges. The symptoms of shock, too, are in no wise different from those of concussion of the brain. The authors who affirm the existence of this lesion declare, in the absence of demonstrable anatomic changes, that it is a molecular affection. Oppenheim is positive that hemorrhages into the cord and meninges may take place without external injury to or laceration of these structures. He even states that lacerations of the substance of the cord may occur in consequence of concussion of the latter or of the body as a whole. In direct opposition to these teachings we have the opinion of Wagner and Stolper, based on the observation of a large number of cases. These authors, as previously stated, deny the occurrence of the injury in question. If the cord is lacerated, it is certainly incorrect to speak of "molecular changes," since, in this case, there is a definite anatomic lesion.

Traumatic compression of the cord is stated by Wagner

and Stolper to be an injury giving definite clinical symptoms, but not causing demonstrable anatomic changes. The symptoms to which it gives rise are ascribed to disturbances of circulation involving the lymphatics as well as the blood-vessels, and leading to a temporary paralysis of the nerves. As soon as the nervous elements are relieved from compression their functional power returns; if the pressure increases, however, the same lesions of the cord are produced as in cases of acute contusion.

Contusion of the cord is an injury that is usually observed in connection with a fracture or dislocation in the vertebral column, the cord being bruised by the arches. The localized symptoms that follow the injury will be referred to later on. Contusions may also be caused by the sudden bend in the spine in cases of sprains. Another consequence of sprains is sometimes seen in the stretching of the cord in its long axis. As the result of the strain to which it is subjected, the cord-substance gives way at the point of least resistance; it is more or less torn and is infiltrated with extravasated blood.

The symptoms of contusion depend upon the extent of the lesion, which may partly or completely sever the cord in its transverse diameter. In some cases we find the symptoms characteristic of the unilateral lesion of Brown-Séquard.

3. INJURIES OF THE SPINAL MENINGES.

Lesions of the dura mater do not give rise to special functional disturbances, unless complicated by involvement of the nerves.

Wounds and lacerations of the dura mater do not cause noteworthy functional disturbances, unless nerves are involved in the injury. The cicatrices that follow may, however, exert pressure or traction on the nerve-roots passing out at the level of the lesion, producing conditions of chronic inflammation with symptoms of irritation and more or less marked functional disturbances.

Extramedullary hemorrhages (hematorrhachis) [Traumatic extramedullary hemorrhage, occurring as a distinct lesion without injury to the spinal cord, is extremely rare, if it ever occurs.—ED.] may take place internal or external to the dura mater. If the dura remains intact, the blood passes into the epidural space, between the dura and the bone; otherwise it enters between the dura and arachnoid, forming a subdural hematoma. The hemorrhage is chiefly venous, and shows a tendency to flow downward, so that, although the hemorrhage may have its origin in the cervical region, it may spread through the entire spinal canal. After fracture of the base of the skull, too, blood extravasations have been observed in the spinal canal. Extramedullary hemorrhages are not of frequent occurrence as a separate lesion, and, according to the results obtained from experiments on dogs, they cause no permanent injury to the cord itself. In these experiments the paralysis disappeared after two days. The chief symptoms are as follows: pain running down the spine, lancinating pains in the extremities, fibrillary muscular spasms along the ribs, muscle-waves, tremor, clonic and tonic muscular spasms. Paralyses are seldom seen; bladder and rectum are not affected.

The spinal meninges may be secondarily infected in consequence of wounds or of metastatic processes,—tuberculosis, for instance,—and may become the seat of an inflammation that subsequently assumes a purulent character (acute meningomyelitis; pachymeningitis and leptomeningitis). If the suppurative process is intense, it is probably always fatal. In less severe cases it may lead to the formation of extensive adhesions between the dura mater and the pia mater, which again cause disturbances of circulation in both the lymphatic vessels and blood-vessels of the cord, and, consequently, compression of the latter.

4. TRAUMATIC HEMORRHAGES IN THE SPINAL CORD.

[Traumatic hematomyelia is one of the most interesting of traumatic disorders of the nervous system. In severe general injuries, when it occurs as a complicating factor, its individuality is usually lost in the general mutilation. But when it constitutes the chief lesion, it very often has distinctive and recognizable symptoms. In its most characteristic form it occurs without any bone-injury being demonstrable during life, and many autopsies have proved that such a lesion in the spinal cord is possible without the integrity of the spinal column being interfered with. This variety, which I have called "primary" hematomyelia (the word primary indicating that the bleeding results directly from the violence, without the intervention of crushing or pressure by bone), is found almost exclusively in the lower cervical and upper thoracic regions, and results from sudden forced flexion or extension of the neck: *e. g.*, diving in shallow water. The symptoms come on immediately.

Since hemorrhage occurs first and most freely in the gray matter, the symptoms of primary hematomyelia are gray-matter symptoms: viz., atrophic paralysis with rapidly ensuing atrophy and diminution of electric excitability. Since the gray matter has to do with the transmission of sensations of temperature and pain, certain of these cases present very interesting sensory symptoms. They are a loss of the ability to recognize heat or cold or to feel pain, although touches continue to be normally perceived. Thus the sensory symptoms are those of syringomyelia. In some cases sensory symptoms are altogether absent.

In addition to the gray-matter symptoms of primary hematomyelia, there are present others indicating pressure on the pyramidal tracts. These consist in paralysis or weakness in the legs, loss of bladder control, etc. The knee-jerks may be abolished at first, to return in a few

days and to become exaggerated. Often they are exaggerated or hyperactive from the outset. Sometimes they remain unaffected throughout.

These symptoms vary, in extent and association, with the amount of hemorrhage. In slight cases many of the cardinal symptoms of spinal-cord injury are absent. In a very extensive hemorrhage the clinical individuality may be masked and the case may appear to be one of ordinary transverse lesion. The ones presenting the syringomyelic type of anesthesia are the most characteristic. When the hemorrhage is very slight, the paralysis may affect the muscles of one member only, without any sensory symptoms.

The condition known as diplegia brachialis traumatica, or paralysis of both arms following injury to the neck, is due, in my opinion, to hemorrhage into the cord-substance, and not to extramedullary hemorrhage, as is generally taught.

These cases of primary hematomyelia should be recognized more readily than they seem to be, for they present, in general, the most hopeful outlook of any spinal-cord injury. The symptoms are alarming at first, but they often recede very rapidly, and after being totally paralyzed, many of these patients are able, in a few months, to resume their occupations.

Case of primary hematomyelia presenting the syringomyelic type of anesthesia. On or about June 20, 1898, a strong man fell thirty feet through a hatchway and was instantly paralyzed in both legs. He was taken to the Hudson Street Hospital, in the service of Dr. P. R. Bolton. Symptoms: Arms unaffected in any way; complete motor paraplegia of legs, with retention of urine; diminution (almost extinction) of both knee-jerks. Sensibility to touch and pain were normal, but a pronounced thermo-anesthesia was present below the nipples. No bed-sores. Recovery was very rapid. The retention of urine disappeared in ten days, and in six weeks the patient could walk unsupported. On August 23, 1898, the following notes were made: The man walks easily and without a marked limp, although the right leg is stiff. All movements of the lower extremities are performed quickly and with good force. Both knee-jerks have become exaggerated, and there is also double ankle-clonus. Thermo-anesthesia has in large part disappeared, though traces of it are still

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present in the legs, especially the left. At the first examination the vertebral column appeared normal; at this second examination there was a kyphosis in the upper dorsal region. The patient had secured a place as night-watchman, and said he could perform his duties without fatigue. Thus in two months from the receipt of the injury this man had recovered from a complete motor paraplegia, with bladder-paralysis, and had again become a bread-winner.

Case of primary hematomyelia giving the symptom-complex known as diplegia brachialis traumatica.

A man aged fifty-four years on December 2, 1899, was run into by a light carriage. He became unconscious momentarily, and is unable to state exactly how the accident occurred. Thinks that he was struck in the neck by a shaft and that then the carriage passed over him.

Examination shortly after the accident showed fracture of two ribs, scalp-wounds, and paralysis of both upper extremities. The legs were unaffected. There was no disturbance with either bladder or rectum, and the patient was unaware of any disturbance in sensation. He was treated for ten days in the hospital and then came to the Vanderbilt clinic, where I examined him. During his stay in the hospital he suffered severe pain in the neck, which radiated down both arms.

The following are my notes of his condition on January 10, 1900. Slight prominence over the seventh cervical spine. No crepitus or false motion. Movements of the neck performed freely. No disturbances in lower extremity. Knee-jerks normal. The only sensory anomaly was a diminution in the sensibility to pain on the inner surfaces of both arms. The muscles of the forearm were weaker than normal, but were not paralyzed. There was, however, extensive paralyzes of atrophic type (atrophy, fibrillary twitchings, lowered electric excitability) in both upper arms and both shoulders. The muscles chiefly affected were the deltoid and the supraspinati and infraspinati. Under cauterization, electricity, and the iodid of potash the patient has been gradually improving (January 25th) and his chances for fairly complete recovery seem good.—ED.]

Intramedullary hemorrhages eventuate in the partial destruction of the cord-substance proper, within which they originate. According to Wagner and Stolper, the accident is usually the result of the strain to which the cord is subjected in cases of sprains caused by overflexion of the spine. Paralysis is a prominent and characteristic symptom of intramedullary hemorrhage. The symptoms mentioned under extramedullary hemorrhage may also be in evidence.

The following points deserve special attention: Intramedullary hemorrhages in the cervical region down to and including the fourth segment cause death by paralysis

of the phrenic nerves. In the lower cervical region the hemorrhages cause paralysis of the brachial plexus. In the dorsal region hemorrhage rarely or never occurs except in connection with injuries of the vertebrae. Intramedullary hemorrhages in the lumbar region are, on the other hand, very frequently noted, and give rise to the following symptoms: paralysis affecting the lower extremities, the bladder, and the rectum, and disturbances of sensation. These symptoms may persist for a long time.

5. SYMPTOMS OF INJURIES OF THE SPINAL CORD.

A. Injuries of the Cervical Region of the Cord.

Total transverse lesions in the cervical region are fatal; death is consequent upon respiratory failure due to paralysis of the phrenic nerves. If the lesion does not at once involve the whole diameter of the cord, death may not occur at once; it may follow secondary hemorrhage or secondary injuries due to dislocation of the fragments of bone in cases of fracture. On account of the origin of the fibers of the phrenic nerves, the most dangerous transverse lesions are those involving the cord as far down as the fourth cervical segment, inclusive. In cases of partial transverse lesion at this level respiration ceases on the affected side; that side of the thorax does not move, and no breath-sounds can be heard, while the diaphragm lies higher than on the normal side. A hypostatic pneumonia is likely to develop.

Total transverse lesions of the fifth cervical segment are followed by a complete loss of motor power of all the muscles supplied by the brachial plexus. In addition to this, there is paralysis of the centers below the lesion; reflex action is, therefore, totally abolished, and there is paralysis of sensation of the extremities and of the body up to the level of the second rib. It is characteristic of a transverse lesion of the sixth cervical seg-

ment that the radial side of the arm remains free from paralysis as far down as the wrist.

The following symptoms are common to all lesions of the cervical region of the cord: (1) Vasomotor disturbances; (2) oculopupillary symptoms; (3) disturbances of reflex action.

The temperature may rise extremely high. In one case seen by Weber in London it was 41.1° C. shortly before death; and 44° C. shortly after death, eight hours subsequent to the accident. Very high temperatures (41.9° and 42.5° C.) have likewise been observed by Wagner and Stolper. Other cases have exhibited a sub-normal temperature and a slow pulse.

In respect to the oculopupillary symptoms, the following points are to be noted: If there is paralysis of the sympathetic, the pupil will be found contracted. In case of partial transverse lesion, the contraction is seen on one side only, while it affects both sides in cases of total transverse lesion. The lids droop and do not close normally. There are changes in the resistance of the eyeballs. Partial lesions cause an increased activity of the sweat-glands of one side of the face. In some cases of injury to the cervical cord the entire body is affected by hyperidrosis.

Total lesions of the cord as far down as the seventh cervical segment are followed by total abolition of reflex action, including the reflexes of the eye.

The rapidity with which death follows total transverse lesion of the cervical cord depends, as before indicated, on the level of the injury: the higher up the lesion, the sooner may death be expected. In case of injuries of the lower part of the cervical cord, death is usually to be ascribed to the complications that inevitably follow (paralysis of respiration; vasomotor paralysis; hypostatic pneumonia; paralysis of bladder, rectum, etc.).

Lesions of the dorsal cord are invariably due to injuries of the bony framework—fractures or dislocations.

Total transverse lesions in this region are no less fatal ; death may take place soon after the injury, or may occur in consequence of complications involving the bladder or the lungs. Partial transverse lesions of the dorsal cord may, even in severe cases, progress to a favorable termination. It goes without saying that the upper limit of both motor and sensory paralysis in dorsal lesions lies below that of similar lesions in the cervical region. The symptoms of paralysis following partial transverse lesions of the dorsal cord often persist for a long time, characterizing the case even in its later stages. They are as follows : Disturbances of sensation ; sensitiveness of the spine or the spinous processes ; disturbances of mobility of the spine, frequently attended by inability to stoop ; disturbances of gait.

The lumbar region of the cord extends from about the eleventh or twelfth dorsal vertebra down to the first or second lumbar vertebra, where the cauda equina begins. Injuries of the lumbar cord are followed only by paralysis of the lower extremities and of the bladder and rectum.

Of cases of unilateral lesion it may be stated, in general terms, that there is a motor paralysis on the side of the injury and a sensory paralysis on the opposite side. Special symptoms may be mentioned as follows :

1. Muscular paralysis with atrophy (curable) below the level of the lesion.

2. Rise of temperature in the paralyzed extremities.

3. Hyperesthesia in respect to touch, pain, heat, and cold.

4. Loss of muscle and pressure senses.

5. Exaggeration of the tendon-reflexes.

6. In unilateral lesions involving the cervical cord there is contraction of the pupil and drooping of the lid.

Lesions of the cauda equina and the conus terminalis, which occur as the result of fracture, are followed by : anesthesia of the skin of the coccygeal region and of the

region of the anus and external genitals ; impotence ; and paralysis of the bladder and rectum.

The same symptoms, however, appear in cases of injury of the lumbar plexus or of the sacrococcygeal plexus.

B. Injuries of the Spine.

Statistics.—My observations cover 151 cases of injury of the vertebral column. The cervical region was involved in 28 cases, the dorsal region in 65, and the lumbar region in 58. My cases of injury of the spinal column, including those of injury of the cord, amount to 2.96 % of all the cases of traumatism that came under my observation. According to Wagner and Stolper, out of 70,393 cases of traumatism the spine was involved in only 500, or in 0.71 %. Of my 151 cases there were 62 contusions and sprains and 39 fractures and dislocation-fractures. Wagner and Stolper cite 136 cases of fracture, including dislocation-fractures.

1. Contusions of the Spine.

Contusions of the spine vary greatly in effect according to their location, intensity, and nature. Light cases of contusion may give rise to no symptoms at all, and necessitate no interval of rest from work. In some cases there is pain in the spine and inability to stoop, although nothing abnormal can be detected on examination. In other cases, especially when the spine is struck at a tangent, we may observe the development of a tumor, over which a coarse desquamation takes place. This condition has been called "*décollement tramatique*" by the French, and "*meningocele spuria traumatica*" by some German writers. Wagner and Stolper do not accept the theory of a connection between these cystic tumors and the subdural space. At any rate, no serious prognosis attaches to them. Lininger, who has given the subject much attention, states that the prognosis is favorable, since the spinal cord is not involved. The condition can be cured by tapping. The symptoms are

as follows: Pain in the lumbar region, disturbances of mobility of the spine, pain radiating toward the lower extremities, and sometimes paralysis in the latter.

Contusions may also cause intradural and extradural hemorrhages, sprains, fractures, and dislocations of the spine. They are sometimes followed by severe inflammations of the cord-substance.

Fracture of the sacrum, with lesion of the cauda equina. Sequel, extreme degree of incapacity for self-support.

A man, thirty-five years of age, fell from a height of twenty-eight feet. He was discharged from the hospital in three weeks. On examination of the patient, who was a rather large, poorly nourished man, I found the sacrum thickened, while the muscles of the leg and the small muscles of the foot were paralyzed and flabby. There was difficulty of urination and defecation, and impotence. His gait was spastic-ataxic; he walked with a cane. Insurance allowance, 66 $\frac{2}{3}$ %.

Case of severe contusion of the dorsal region, complicated by "concussion of the cord" (dislocation-fracture?), and fracture of ribs on the left side. Sequel, diffuse chronic myelitis. Death in three years.

A carpenter, thirty-three years of age, fell from a scaffolding eight feet high on December 13, 1892, striking with his back on a beam. He was treated at home, where he lay in bed, partly on account of a sprained ankle. I examined him April 26, 1893. He was a rather large man, of vigorous build and pale complexion. He wore an expression of depression. He appeared to find difficulty in supporting the upper part of his body. He walked with a shuffling gait, especially noticeable on the right side. The dorsal spine was curved to the left, beginning at the sixth dorsal vertebra; the spine was painful from that point all the way down. The sixth and seventh ribs on the left side were perceptibly thickened in the anterior axillary line and were painful on pressure. The reflexes of the trunk were exaggerated; on the left side the patellar reflex was apparently lost; on the right side it was present, but was extremely weak. Sensibility on the left side of the body was distinctly diminished below the level of the spinous process of the sixth dorsal vertebra. The left lower extremity was considerably atrophied. The mobility of the spine was greatly diminished.

Treatment.—Massage of the back, but without any effect; the condition of the patient gradually grew worse.

Subsequent Symptoms.—Atrophy of the left side of the face, conjunctivitis, jaundice, contracted pupils, loss of pupillary reflex, intercostal neuralgia, girdle sensation, lancinating pains radiating toward the thighs, and cystitis. The patient found walking more and more difficult. On November 26, 1895, he was taken to a hospital. On catheterization 2550 gm. of urine were drawn. Sensibility was greatly diminished; the patellar reflexes were exaggerated. Fever was present and the urine contained considerable albumin. Death occurred

December 14, 1895, with symptoms of heart-failure. Postmortem examination showed multiple myelitis, dilatation of the left ventricle of the heart, nephritis, and cystitis.

Case of severe contusion (fracture?) of the tenth and eleventh dorsal vertebræ, complicated by "concussion of the cord."

Sequel, complete incapacity for self-support in consequence of a traumatic myelitis.

A mason, thirty-eight years of age, fell on August 4, 1890, from a flight of steps about eight feet high, striking on his loins. He was treated in hospital for three weeks; subsequently at home by injections and baths. I examined him November 3, 1890. He was a man of middle size and of pale complexion. The spinous processes of the tenth and eleventh dorsal vertebræ were somewhat thickened; the spine was painful to pressure below the spinous process of the sixth dorsal vertebra and was greatly limited in mobility. The body was held stiffly; the gait was spastic-ataxic; and walking was very difficult. All the reflexes, especially those of the left side, were exaggerated. The patient was impotent. There was retardation of urination and of defecation, the latter always being very painful. The condition of the patient has remained unchanged up to date.

Case of fracture of the skull, contusion of the cervical region of the spine, and concussion of the cord.

A mason, thirty years of age, fell from a scaffolding fifteen to eighteen feet high on May 4, 1896. He was unconscious after the accident and remained so until he was taken to the hospital. Very few data are obtainable for this period; during the first few days the urine is said to have been bloody. I examined him August 5, 1896. He was a large, vigorous man; there was a small scar and depression on the left parietal bone; the spinous process of the third cervical vertebra was perceptibly thickened, as were also the spinous processes of the sixth and seventh dorsal vertebræ. The latter were very sensitive to pressure. The left pupil was dilated and reacted slowly; the pulse was increased in rapidity. The spine was held fixed on every attempt at motion. On November 6, 1896, he was allowed 30% insurance. He was at that time perceptibly improved also in respect to external signs. Later he was allowed 66.66% insurance on the ground of a traumatic neurasthenia.

Incomplete fractures of the vertebræ may be caused indirectly by a contusion acting in the long axis of the spine—by a fall on the buttocks or the feet, for instance, or when the head is struck by falling objects. Contusions of the spine have the least favorable prognosis when the cervical region is involved; the consequences may, however, be no less serious in case of contusions of the dorsal region.

Serious consequences may follow such injuries as the

incomplete fractures just mentioned or contusions due to blows on the spine or to kicks on the shoulder or neck, etc. The cancellous tissue of the vertebræ remains soft for a long time after fractures, complete or incomplete, sometimes continuing so almost for one year. The injury may at first give rise to no symptoms whatever, especially

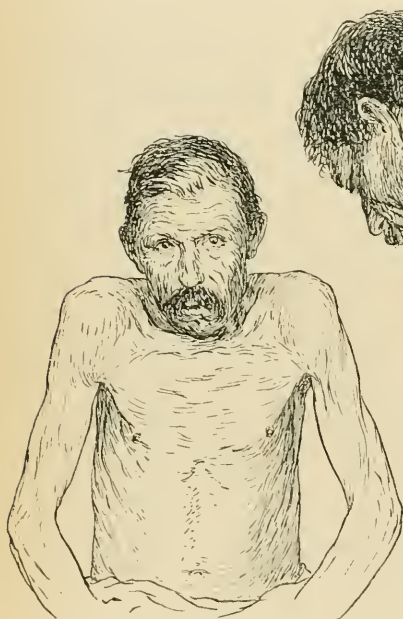


Fig. 7.



Fig. 8.

when the patient lies quietly in bed. When he begins to walk again, however, the weight of the body causes the gradual development of an angular curvature, which causes more and more pain (Kümmel's disease) (spondylitis traumatica). The kyphosis may be very slightly marked or very apparent. For the early treatment of the injury Kümmel recommends rest in bed, with extension

applied to the head. Later, when the patient begins to walk, he is to wear a supporting apparatus (corset, etc.). These cases run a very chronic course, partly because of the softened condition of the cancellous tissue, partly because of the very slow absorption of the crushed intervertebral discs.

In addition to the deformity of the spine, the symptoms are as follows: compression neuritis, due to the narrowing of the intervertebral foramina, exaggerated reflexes, neurasthenic disturbances, psychic depression, etc. The degree of incapacity for self-support varies greatly in different individuals, depending on the intensity of the symptoms.

A case of contusion of the neck. Sequel, tuberculosis of the cervical vertebræ. Death.

A mason, fifty-four years of age, fell headlong from a scaffolding about ten feet high on the 17th of May, 1895, striking on the back of his neck. He was unconscious for a short time. He was taken home and lay in bed for four weeks, receiving only medicinal treatment. He had the feeling after his fall of having "broken his neck." He entered my hospital August 3, 1895. He was a rather large, thin, poorly nourished man. Until the accident he is said to have been perfectly healthy and "straight as a board." The patient complained of headache, vertigo, pain in the neck the lumbar region, between the shoulder-blades, and on movement of the head. On examination I found a sharp angular curvature at the junction of the neck with the dorsal spine. The whole cervical region of the spine was very sensitive to pressure; movement of the head was difficult. When lying in bed, it was necessary to place a support under the head. On looking at the patient from the front the neck appeared to be sunk into the body. The arm-reflexes were exaggerated. The pulse was more rapid than normal. The patient was discharged on October 19, 1895, with an insurance allowance of 100%. He died April 18, 1897, of tuberculosis.

2. Sprains of the Spine.

Sprains are caused by the same forces that produce dislocations; their action is, however, not carried so far. Violent movements of flexion, extension, rotation, or lateral flexion are the factors concerned in these cases. Although the process stops short of dislocation, capsules and ligaments are often torn and pieces of bone may be

broken off—bits of the oblique processes, for instance. It is very important to remember that sprains of the cervical region of the spine may cause death by compression of the cord. Fatal results are observed only when the cervical spine is involved, which, in consequence of its great flexibility, is exposed to an extreme degree of torsion. Sprains are almost out of the question in the dorsal region, certainly between the first and the tenth dorsal vertebræ. They may, however, take place in the articulations between the transverse processes and the ribs, or between the ribs and the bodies of the vertebræ, causing lacerations of ligaments and capsules.

Sprains are more likely to occur in the lumbar region than in the dorsal, but fatal cases are practically excluded. We will refer here to only one form of sprain in the lumbar region, which is of rare occurrence. It involves the oblique processes of the fifth lumbar vertebra and those of the sacrum in the lumbosacral fossa. In extension of the spine the two oblique processes glide backward in the lumbosacral fossa. Sudden or violent overextension may cause a laceration of ligaments or capsules at this point. The injury leads to extravasation of blood and gives rise to pain, which, although never very severe, may interfere with stooping.

Sprains that involve the spine in its whole length may give rise to *strains* of the cord, followed by severe symptoms at first. The prognosis is, however, usually favorable.

The diagnosis of a sprain always involves some difficulty, which increases with the time that has elapsed since the accident. When we find that the spinous processes and lateral parts of the vertebræ are in normal positions, and that no anatomic changes can be determined, we are able to exclude fracture and dislocation, and, in connection with the following symptoms, to make a diagnosis of sprain: a stiff way of holding the body; rigidity of the muscles of the back; fixation of the spine on move-

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ment of the body ; and pain. The pain may be more severe than in cases of dislocation, and may persist for a long time. There may be a considerable degree of incapacity for self-support, especially if neurasthenic disturbances manifest themselves.

3. Dislocations of the Spine.

For anatomic reasons dislocations are most likely to occur in the cervical region ; they occur much less frequently in the lumbar spine, and very rarely in the dorsal region. Leaving aside the special conditions attaching to the odonto-atloid articulation, it will suffice to bear in mind that dislocations of the first four cervical vertebræ may cause immediate death by reason of paralysis of the phrenic nerve.

Dislocations of the cervical vertebræ are in many cases not pure dislocations, but dislocation-fractures, the bodies or processes suffering fracture at the time of injury.

Dislocations of the cervical vertebræ may be classified as follows : (1) Forward dislocations, or flexion-dislocations ; (2) backward dislocations, or extension-dislocations ; (3) lateral dislocation ; (4) dislocation by rotation.

The first form may be directly or indirectly caused by overflexion—by violence applied to the neck in the one case ; by falls on the head, face, etc., in the other. It is possible, also, for a forward dislocation to be produced by overextension. It is exceedingly important for our purposes to bear in mind that dislocations of the cervical vertebræ may also be caused by muscular action. According to Wagner and Stolper, dislocations by rotation not infrequently occur in this manner. We are not concerned here with the cases involving serious injuries of the cord, or with those that terminate fatally, but rather with those in which recovery may be expected, with or without consequent deformity.

Even when properly reduced, and showing no external deformity, dislocations are very likely to cause the head

or neck to be held in a somewhat unnatural position for a long time after recovery. The head is inclined forward, especially after forward dislocations ; this position may be maintained for a long time or even permanently. An abnormal position of the head is always observed in case of dislocation-fractures, or when the displacement was not properly reduced. The following schema, arranged by Wagner and Stolper, is very useful in diagnosing the dislocations of the cervical vertebrae from the abnormal position of the head observed after recovery :

Dislocations by Rotation.

I. Rotation to the right.

1. With the left articular processes in contact at their extremities :

- (a) The head is inclined to the right.
- (b) The spinous process of the dislocated vertebra is slightly displaced to the left.
- (c) The left transverse process is slightly prominent.
- (d) If palpable on pharyngeal examination, the body of the dislocated vertebra, especially its left side, is felt to be slightly displaced forward.

2. With complete displacement of the left articular processes :

- (a) The head is inclined to the left.
- (b) The spinous process of the dislocated vertebra is markedly displaced to the left.
- (c) The left transverse process is decidedly prominent.
- (d) On pharyngeal examination the left side of the body of the dislocated vertebra is felt to be displaced forward.

II. Rotation to the left.

The conditions just described are reversed.

	DISLOCATION BY FLEXION.		DISLOCATION BY ROTATION.	
	Incomplete.	Complete.	Incomplete, with the Articular Processes in Contact at Their Edges.	Complete.
Head, ...	Inclined forward.	Inclined forward or backward.	Inclined laterally and away from the side of the dislocated articular processes.	Inclined laterally, and toward the side of the dislocated articular processes.
Neck, ...	Appears lengthened.	Shortened.	May show a crease on side of the displaced articular processes.	Crease on side of fixed articular processes.
Spinous processes, ...	Separated; not displaced laterally.	Not separated; not displaced laterally.	Displaced laterally and away from side of dislocated articular processes.	Same.
Transverse process, ...	Slightly prominent on both sides.	Decidedly prominent on both sides.	Prominent on side of non-displaced articular processes.	Decidedly prominent on side of fixed articular processes.
Body of the vertebra. . .	Slightly prominent.	Decidedly prominent.	Slightly prominent, especially on side of non-displaced articular processes.	Decidedly prominent on same side.

Even after successful reduction we often meet with *paralysis, malposition of the head, diminished mobility, and crepitation* for some time subsequent to the injury. These disadvantages can be largely overcome by massage and gymnastics.

Dislocations of the dorsal vertebræ are, as already stated, very unusual accidents, and probably are always associated with fractures.

The conditions obtaining in the lumbar region are more favorable to the occurrence of dislocations, but even here

they are only observed in cases of very severe traumatism directly applied to the spine, and then usually in the form of dislocation-fractures.

When the injury involves the cord, we have the various symptoms already described.

4. Fractures of the Vertebrae.

As in all cases of injury of the spine, the chief danger in fractures is involvement of the cord. We must not concern ourselves here with cases of total transverse lesions, in which death occurs immediately or soon after the accident; they have already been sufficiently discussed for our purposes. Our interest lies in fractures causing only partial transverse lesions, or lesions of any kind followed by recovery and involving the future health of the patient.

The disturbances of function caused by injury to the cord do not always bear an exact relation to the severity of the lesion. Fractures attended by serious lesions of the cord may, for example, have a favorable outcome, while cases in which the injury to the spine is slight or difficult of diagnosis, with no sign of involvement of the cord, may be followed by grave functional disorders and a high degree of incapacity for self-support.

Fracture of the spine is, on the whole, a rare accident; it is encountered, however, with relative frequency in certain industries. *Bruns* estimates its proportion to fractures in general at 0.4%, while *Wagner* and *Stolper*, in a series of observations extending over twenty years, found it in 2.07% of fracture-cases. These statistics of the latter authors are based, however, on accidents occurring in the coal-mines of upper Silesia, and conditions favorable to spinal fracture are found preeminently in this industry, with its many opportunities for falls from a height, cavings-in, and the falling of masses of coal or rock on the miners when they are stooping over. Quarrymen and all classes of workmen employed in the building

trades are exposed to similar dangers. In the latter trades, 35% of all accidents are caused by falls from more or less high places, and from 18 to 25% by blows from falling objects. These figures sufficiently indicate the danger of spinal injury in such employments.

In my own series of cases injuries of the spine amounted to 3% and fractures of the spine to 1.5% of the total number of accidents.

Fractures of the spine are usually the result of indirect violence, such as falls, striking on the feet or buttocks, or blows from falling objects received when stooping, causing overflexion, or blows from falling objects received on the head or shoulders. There are exceptional cases, however, as we shall see later on, in which fracture is due to direct violence. Fracture may be caused by muscular action, but such an accident is usually to be explained by a diseased condition of the bone consequent upon syphilitic or tubercular inflammation, etc.

For anatomic reasons it will be advisable to discuss fractures as they occur in the three main divisions of the spine respectively. In addition, I shall refer separately to the lesion as it affects the atlas and axis, since, because of their union through the odontoid process, they are more closely connected than any other two vertebræ, forming a unit in respect to functional action.

Fractures of the Cervical Vertebræ.

These fractures are classified as follows: (1) Fracture of the body; (2) fracture of the lamina; (3) fracture of the processes.

Class 3 is subdivided into: (*a*) Fracture of the spinous processes; (*b*) fracture of the transverse processes; (*c*) fracture of the oblique processes.

The various forms of fracture of the bodies and laminae will be referred to later on.

In the atlas we meet with transverse fractures of the ring, and with fractures of the transverse processes.

PLATE 8.

Case of Healed Fracture by Rotation of the Third Cervical Vertebra and of the Corresponding Spinous Process.

The head is slightly turned to one side. The colored illustration shows the forward inclination of the head and the swollen appearance of the neck (which has persisted up to the present time).

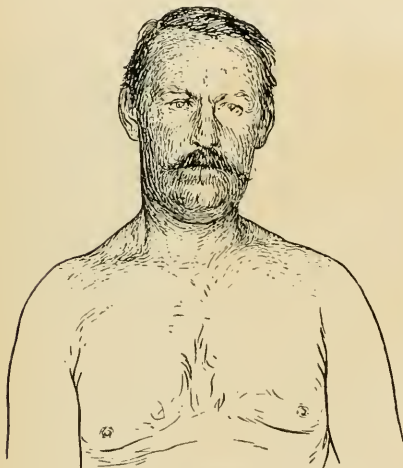


Fig. 9.

A mason, forty-three years of age, fell from a ladder from the height of about $1\frac{1}{2}$ stories, on August 8, 1893. It is not known in what manner he struck the ground. He was treated for seven weeks in the hospital and for six months afterward in my clinic, receiving full insurance allowance during that time. He then resumed work, but treatment by massage and gymnastics was continued. The cord had not been injured, and the only difficulty manifested was diminished mobility of the head. At first it could

be neither flexed nor extended, while lateral flexion and rotation were limited. Percussion of the spinous processes of the cervical vertebræ caused, reflexly, an immediate elevation of the shoulders.

In the course of time the patient was able to perform all the duties of his trade. The accompanying illustration (Fig. 9) shows the slight rotation of the head to the left and the apparent shortening of the neck on the left side.

Insurance allowance : for first eight months, 100% ; for the following six months, 50% ; for one year afterward, 33% ; since that time, 15%.

Wagner and Stolper cite a case observed by B. Phillipps, in which the ring of the atlas was transversely broken, the anterior arch, together with the odontoid process, being displaced forward, without causing injury to the cord. If



the atlas has a spinous process, it may be fractured by extreme degrees of flexion of the neck. However, fractures of the atlas are, on the whole, very rare accidents.

The axis may be fractured in any of its parts. The odontoid process is invariably fractured in case of forward dislocation of the atlas.

A carpenter, sixty-seven years of age, fell from a scaffolding nine feet high on the 17th of April, 1897, receiving the following injuries : dislocation of the left clavicle at its sternal articulation, concussion of the brain, incomplete rotatory dislocation of the second cervical vertebra to the left. The cord was not injured. The patient was unconscious for several hours.

He was treated at home for about four months, lying in bed for three weeks. He is said to have walked very little subsequently. He entered my hospital August 7, 1897.

Subjective Symptoms.—Rigidity of the neck, inability to move the same. The mobility of the shoulder was very limited and the left arm was almost useless.

The patient appeared somewhat feeble ; his head was held rather stiffly and was slightly inclined forward, the chin being turned a little to the right, while the left ear was slightly lower than the right. The spinous process of the second vertebra was distinctly rotated to the left. Rotation of the head was very limited and painful : anteflexion caused no difficulty, but retroflexion was impossible. The muscles of the left side of the neck were flabby. Pressure on the spinous process of the axis gave rise to pain and to a quick movement of extension. The patient was discharged November 27, 1897. At that date the head was held straight and could be moved in all directions without pain. Otherwise, the condition as previously described remained unchanged. The insurance allowance was reckoned at 45%.

Case of healed dislocation fracture of the fourth cervical vertebra, complicated by injury of the cord, laceration of the ligamentum nuchæ, and fracture of the spinous process of the third cervical vertebra. The fracture was caused by overflexion. The nasal bones were also broken.

A mason, forty-nine years of age, fell from a scaffolding on November 3, 1886, striking on his nose and turning a somersault, which caused overflexion of the neck. At the hospital a diagnosis was made of intramedullary hemorrhage. There was paralysis, both motor and sensory, of all the extremities. I examined the patient two years later. He had grown very old in appearance and held his head inclined forward, as shown in the accompanying illustration. (Fig. 10.) The spinous process of the fifth cervical vertebra was very prominent. Just below the third spinous process there was a depression, and a little below this could be felt an elastic, cord-like object, which could be pushed into the depression. On percussion of the cervical region of the spine with the percussion-hammer the shoulders were elevated with lightning-like rapidity, while the head was thrown backward. The mobility of the head was limited ; there was

no paralysis. The tips of the fingers were affected by paresthesia. Early in 1898 I took an X-ray photograph, by which the diagnosis was confirmed. The insurance allowance was 100% for one year; then 50%, and later, 15%, when the patient resumed regular work. It had to be raised to 50% later on, and remained at that figure until his death, which occurred in May, 1899, from pulmonary tuberculosis. There had been no improvement in the position or mobility of his head.

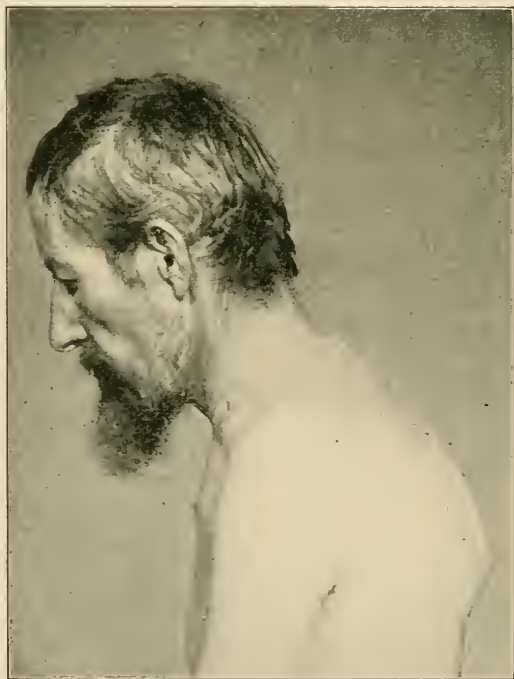


Fig. 10.

According to Wagner and Stolper, fractures of the spinous process and laminae of the axis are always due to direct violence. Fractures of the body or laminae, or of the odontoid process, are exceedingly dangerous injuries, death being liable to occur from penetration of the cord by fragments of bone. Notwithstanding the grave prog-

nosis attaching to fractures of the axis and atlas, they do not necessarily prove fatal in all cases. Cases of recovery from fracture of the odontoid process, for instance, are on record.

Fractures of the axis and of all the other cervical vertebræ are caused by indirect violence. They are usually the result of forced flexion (compression-fractures), the bodies of the vertebræ being compressed in their vertebral diameter. The lesion may be due to a fall on the head or to blows received on the latter from falling objects. It is usually accompanied by concussion of the brain, which is very likely to divert attention from the spine to the head. Sometimes there is only a temporary condition of shock, and cases of fracture of the axis have occurred in which the injured individual has proceeded on his way after recovering from the shock. It is quite possible, under such circumstances, for fracture of the vertebræ to be overlooked; and if the patient actually visits a physician himself, the occurrence of the fracture may later on be denied and its existence declared to be impossible.

The spinous processes most subject to fracture are those of the second (which is long), the sixth, and the seventh vertebræ. The injury may be caused by direct violence or may result from overextension, the spinous process next below acting as a fulcrum. In other cases it occurs as an accompaniment of dislocations due to overflexion, being caused by traction on the part of the ligamentum nuchæ. These fractures usually involve no danger to the patient.

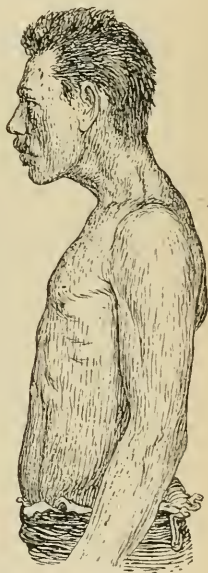


Fig. 11.

Fractures of the laminae, on the other hand, are much more serious injuries, being very liable to cause lesions of the cord.

The prognosis is good, as a rule, in respect to fractures of the transverse processes and of the articular processes.

Case of healed fracture of the spinous process of the seventh cervical and first dorsal vertebræ.

A carpenter, thirty years of age, fell from a height of twelve feet on June 29, 1891, striking on the neck. In addition to the injury named he suffered a sprain of the left ankle. When I examined him, September 23, 1891, I found the head held as in the accompanying illustration. (Fig. 11.) All movement of the head was very difficult, and the spinous processes of the injured vertebræ were swollen and sensitive to pressure. The central nervous system was intact. Gradual improvement resulted from treatment by massage and from passive motion. Insurance allowance, 40% for the first six months; 20% for the following year. After this time the patient was fully capable of self-support.

Symptoms of Healed Fractures of the Cervical Vertebræ.

In all cases of healed fractures of the cervical vertebræ we can observe a peculiar and rather stiff position of the head. When it is inclined forward, we can assume the lesion to have been a fracture or dislocation-fracture caused by overflexion. There is often at the same time a slight rotation of the head (*caput obstipum*), which is usually to be ascribed to a unilateral rotatory dislocation or fracture. In many cases the neck is permanently thickened and swollen. In case of fracture of the spinous processes these are felt to be thickened, and can usually be easily seen. When there is a rotation of the head, the spinous processes are found to be displaced. Sometimes the cervical region of the spine is markedly convex posteriorly.

Paralyses affecting the cervical or brachial plexus may be caused by hemorrhage within the cord or by pressure of masses of callus on the nerves at the intervertebral foramina.

The most important of the functional disturbances are the limitations of mobility. A workman may be seriously inconvenienced by inability to raise his head. Limitation of lateral movement is also extremely annoying.

Movement of the head frequently gives rise to cracking sounds, usually not accompanied by pain, but so unpleasant that the individual affected is apt to avoid moving his head as much as possible.

There is not necessarily a loss of capacity for self-support, unless there are cerebral symptoms or paralyses. If the latter are present, the incapacity for self-support always reaches a high degree.

Case of healed dislocation-fracture of the cervical vertebræ, complicated by concussion of the brain.

A carpenter, thirty-four years of age, was caught under a falling building on February 3, 1897. Lesion: severe confusion of the cervical region of the spine and of the left arm. He was in the hospital for three and a half weeks, and came under my care on May 3, 1897.

The patient was a large man, of vigorous build. The head was somewhat inclined forward and to the left side, the left ear being on a slightly lower level than the right. The second spinous process was slightly displaced to the left. There was some stiffness of the neck, and movement of the head was greatly restricted. On passive motion there was slight crepitation in the spinous processes of the lower part of the cervical region. The right pupil was dilated and reacted slowly. The patient complained of dizziness. He could raise his left arm only to an angle of 100 degrees, and could not close his left hand. The whole left arm showed signs of paretic disturbances. The left patellar reflex was exaggerated; the gait was rather dragging. X-ray photographs showed a healed dislocation-fracture of the fifth cervical vertebra, with slight rotation to the left, confirming the diagnosis of injury to the central nervous system.

Treatment.—Massage and passive motion. Improvement very slow and slight. The patient remained somewhat depressed. Discharged January 20, 1898, with 60% insurance allowance, afterward increased by legal process to 75%. No change in his condition up to date.

Case of healed dislocation-fracture of the fifth cervical vertebra.

A plasterer, thirty-two years of age, fell from a scaffolding six feet high on November 29, 1898, striking the back of his head on a beam. After a very short period of unconsciousness he rose to his feet of his own accord; spontaneous extension movements of the right arm lasting for several minutes are said to have occurred immediately afterward. The head was inclined forward from the first. He walked home and then to the doctor's office, where the fracture was diagnosed and treatment by appropriate position ordered. On the following day he entered a surgical clinic for treatment. After an X-ray photograph had been taken the dislocation was reduced. I examined him on February 3, 1899. He was a man of medium height and of vigorous build. He complained of pain in the back of the neck, radiating toward the shoulders, of inability to move his head, of pain

in the sternum and in the lumbar region after sitting for any length of time, and of numbness of the left arm.

The following points were especially noticeable when the patient was viewed from the side : forward inclination of the head ; marked prominence of the sternocleidomastoid ; prominence of the spinous processes of the fifth, sixth, and seventh cervical vertebræ. The left ear was slightly lower than the right. Movement of the head was limited and painful. The patient wore a stiff bandage around the neck. He is still quite incapable of self-support.

Fractures of the Dorsal and Lumbar Vertebræ.

Fractures of the dorsal vertebræ call for special discussion by reason of the connection of the vertebræ with the ribs. If the transverse processes are involved, the union with the ribs is loosened or destroyed, and after recovery there are likely to be mechanical limitations of mobility, or pain due to neuralgia, or inflammation arising from pressure on the intercostal nerves. Similar symptoms are also observed when the ribs are fractured near their vertebral articulations. The heads of the ribs are frequently loosened or displaced from their articulations with the intervertebral discs in case of fracture of the bodies of the vertebræ. These dislocations are very likely to cause pain on every motion of the thorax. The pain may be localized at the point of injury, or it may radiate in the course of the intercostal nerves involved. In addition, there are disturbances undoubtedly due to lesions of the sympathetic nerve, which passes down the vertebral column close to the costal articulations, and to lesions of its small ganglia, one of which corresponds to each rib, and into which the nerve-branches pass connecting the sympathetic and spinal systems. The symptoms to be attributed to these lesions are disturbances of heart-action, such as slow or intermittent pulse.

When the eleventh or twelfth dorsal vertebra is involved, the conditions that arise from the injury are somewhat different, since these vertebræ are connected with the two floating ribs.

The consequences of injuries of the cord at the various

levels of the dorsal region have already received sufficient mention.

While dislocations or dislocation-fractures are the rule in the cervical region, pure fractures are the chief form of injury affecting the dorsal and lumbar vertebræ. Of these, the lower dorsal and upper lumbar vertebræ are most frequently involved, and by most observers the twelfth dorsal and first lumbar vertebræ are stated to be the seat of injury in the majority of cases. My own statistics fully agree with this conclusion. Wagner and Stolper noted thirty-five fractures of the twelfth dorsal vertebra among sixty-eight cases of fracture and dislocation; and nineteen fractures of the first lumbar vertebra among thirty-four cases of involvement of the lumbar region. Gowers gives very similar figures.

Fractures of the bodies of the dorsal and lumbar vertebræ are compression-fractures in the great majority of cases, being caused by falls on the feet, buttocks, head, or neck, or by blows from falling objects received on the shoulders, or by forced overflexion of the body in cases of caving-in of walls, etc. Such fractures are due to indirect violence, and it may be stated that fractures of the bodies are only in rare instances the result of direct violence.

As a result of the accidents just enumerated the bodies of the vertebræ are compressed in their vertical axis. If at the same time the spine is overflexed, it is the anterior parts of the bodies that are chiefly affected by the compression. As a result we often meet with indirect fractures of one or more of the spinous processes, with lacerations of the ligaments connecting them, especially of the supraspinous ligament. Sometimes the sternum is transversely fractured at the same time. It has not yet been determined how much the transverse and articular processes of the vertebræ are involved in the injury. Wagner and Stolper have found on autopsy that the articular processes and capsules were uninjured in a

number of cases of serious compression-fracture. Nevertheless, it is only reasonable to suppose that, in some instances in which the compression is more marked in the posterior than in the anterior segments of the bodies, the articular processes may also suffer fracture.

The spinous processes are very frequently the seat of fracture; and when they alone suffer, the injury is due to direct violence, usually acting at a tangent and involving several spinous processes at the same time. The indirect fractures of the spinous processes accompanying similar injuries of the bodies of the vertebræ have been previously mentioned.

Fractures of the laminae of the dorsal and lumbar vertebræ occur so seldom that, according to Wagner and Stolper, only five cases are on record so far. These fractures necessarily involve great danger to the cord.

Case of healed compression-fracture of the eleventh and twelfth dorsal vertebræ, complicated by lesion of the cord. Sequel, Kummel's curvature of the spine.

A workman, twenty-eight years of age, fell from a height of one story June 28, 1898. He was treated in the hospital by rest in bed on rubber cushions. There were anesthesia of both lower extremities for four days; retention of urine, necessitating catheterization for three days; absolute constipation for from ten to twelve days. I examined him September 3, 1898, when he had been out of the hospital for eight weeks. He stated that he felt strong enough to work, and wished to do so. He was a man of medium size and vigorous build, of pale complexion and sickly appearance. The spinous processes of the eleventh and twelfth dorsal vertebræ were somewhat thickened and appeared a little separated; they were not painful on pressure. The spine showed a slight posterior curvature in this region. The patient could stoop forward easily, and could raise himself promptly and quickly; lateral flexion and retroflexion were rather difficult. Insurance allowance, 25%.

The patient now began to work again. After twenty-seven days he returned for a new examination, saying that he had pain in the spine and was unable to work. He admitted having worked continuously for ten hours and having carried heavy weights. At this time the *spinous processes of the eleventh and twelfth dorsal vertebræ were somewhat displaced* and the kyphosis was more marked. On December 31, 1898, I made another examination, and found a much increased kyphosis, as illustrated in the accompanying drawing. (Fig. 12. Photographed from outline made with lead wire.) The patient had evidently begun to work again too soon, especially in regard to carrying loads. The

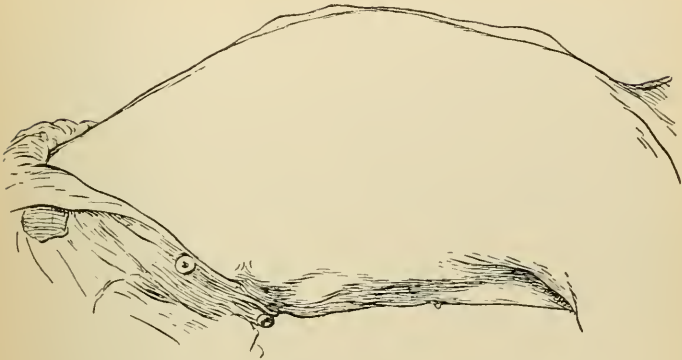


Fig. 13.



Fig. 12.

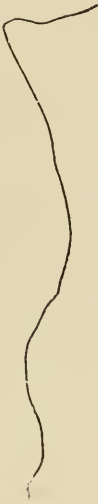


Fig. 14.



L

Fig. 15.



R

Fig. 16.

cancellous portion of the fractured vertebræ was undoubtedly still too soft to give the proper support. On anteflexion the two spinous processes in question stood out, as shown in the drawing. (Fig. 13.) At this time it was difficult for the patient to recover the upright position. On retroflexion (Fig. 14) the cervical and dorsal regions of the spine stood to each other at an angle of nearly ninety degrees; the dorsal region remained kyphotic, while the lumbar region could be flexed in lordosis. On lateral flexion the dorsal region invariably moved in the opposite direction; on flexion to the left (Fig. 15), therefore, the dorsal region became convex on the left side, while the cervical and lumbar regions became concave on the left side; on flexion to the right, the convexity appeared on the right side of the lumbar region. (Fig. 16.) The patient had lost four centimeters in height since his accident. His insurance was raised to 50%

Symptoms of Healed Fractures of the Spine.

As a result of isolated fractures of the spinous processes, usually due to direct violence acting at a tangent, we find the affected processes thickened, prominent, and either approximated or separated more widely than in the normal state. The mobility of the spine is limited for a considerable period; in especially unfavorable cases the limitation may be permanent. Lesions of the spinal cord may be caused by direct penetration of the latter by the fractured process.

The symptoms consequent upon fracture of the bodies are more characteristic. A peculiar stiff manner of holding the body is often apparent at a glance, while on examination of the spine we usually find a spot at which one or more of the spinous processes seem thickened. The fracture of the body may correspond with the spinous process that was simultaneously involved, or it may be situated lower down. It is unusual for it to be at a higher level. The callous thickening of the fractured spinous processes may be so marked as to form a decided angular or rounded gibbosity. In other cases the spinous processes are only very slightly thickened. The gibbosity is, as a rule, largest in the cases of fracture due to overflexion accompanied by compression of the anterior segments of the bodies of the vertebræ. It may increase in size as a result

of walking too soon after the accident (Kümmel's disease). If the gibbosity is marked, the whole back at that level is shaped to a point in the direction of the spine; in the lumbar region especially the normal depressions and curves seen on both sides of the long extensor muscles of the back will be found to have disappeared. As a result of these changes the whole body is sometimes held slightly inclined forward. The opposite condition obtains when the posterior segments of the bodies of the vertebræ are affected by the compression, the curvature of the spine in these cases being lordotic, and leading to a noticeable peculiarity of posture and gait. The latter may be mincing or dragging. The spinous processes may be widely separated or they may be closely pressed together. In all cases of compression-fracture the vertebral column is found to be shortened. In men who have been accurately measured for military service previously to the accident the degree of shortening can be determined with exactness. The thorax frequently appears barrel-shaped. In the region of the fracture the spine shows a certain stiffness, which can best be demonstrated by pressure, with the patient lying on his stomach, in comparison with a normal individual. The muscles of the back often remain atrophied for a considerable period.

Case of fracture of the spinous processes of the tenth to the twelfth dorsal vertebræ. Sequel, perfect recovery.

A workman, forty-five years of age, on July 27, 1896, fell from a scaffolding one story high, striking on his back. He was taken to the hospital, where he was kept in bed on air-cushions and treated by inunctions. I examined him September 10, 1896. He was of medium size and of healthy appearance. He held his body somewhat inclined forward. The tenth to twelfth spinous processes were thickened and prominent. His gait was slow, but not irregular; all motion of the spine was difficult and painful. After deep flexion he raised himself by climbing up his thighs with his hands. The patellar reflexes were exaggerated on both sides. He was treated in my hospital for four months, and was then discharged with 20% insurance allowance. At that time he still complained of pain in the spine, but could stoop easily and quickly. Since January, 1898, he has been in perfect health.

Case of healed fracture of the ninth and tenth dorsal vertebræ, compli-

eated by fracture of the ribs. Sequel: recovery, with serious functional disturbances.

(Compare Plate 11.) A mason, thirty-five years of age, on October 5, 1897, fell from a wall about twenty feet high, striking, so it is said, on the lumbar region. This point could not be definitely ascertained. The patient remained in bed for sixteen days, and after that arose at intervals. Urination and defecation were disturbed.



Fig. 17.

I examined him December 28, 1895. He was of medium size, well nourished, but had a look of ill health. He held his body inclined backward and walked with a mincing gait. From the front his neck appeared short and as if sunk into the thorax. The abdomen was boat-shaped and the thorax appeared somewhat asymmetric. There was relatively marked lordosis of the lumbar region, while the upper dorsal region was somewhat abnormally convex posteriorly. The spinous processes of the tenth and eleventh dorsal vertebrae were considerably thickened. At the time of his military service the patient

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of Surgery and of Clinical Surgery, University of Michigan, Ann Arbor; Emeritus Professor of General and Orthopedic Surgery, Philadelphia Polyclinic. Octavo volume of about 350 pages, handsomely illustrated with original drawings and photographs. Cloth, \$2.50 net. ❀ ❀ ❀

JUST ISSUED.

Although many excellent works have been written treating of the Principles of Surgery, the attempt to render them too comprehensive has marred their usefulness for the undergraduate. The present book is based on the lectures delivered by Dr. Nancrede to his undergraduate classes, and is intended as a text-book for students and a practical help for teachers. By the careful elimination of unnecessary details of pathology, bacteriology, etc., which are amply provided for in other courses of study, space is gained for a more extended consideration of the Principles of Surgery in themselves, and of the application of these principles to methods of practice. ❀ ❀ ❀ ❀ ❀ ❀ ❀ ❀

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had measured 1.61 meters. His present height is only 1.57 meters. There were no paralyses or disturbances of sensibility. All the reflexes were exaggerated, and the pulse was increased in frequency. Motion of the spine was difficult and painful; the patient walked mincingly and with the help of a cane. Insurance allowance 100%; no improvement up to date.

Case of fracture of the twelfth dorsal and first lumbar vertebræ; recovery.

A chimney-sweep, thirty-eight years of age, on December 20, 1888, fell from a height of about 200 feet, fracturing his spine and right ankle. He was treated in the hospital. I examined him March 28, 1889, and noticed the forward inclination of the body shown in the accompanying illustration. (Fig. 17.) The lower dorsal and lumbar regions of the spine were slightly thickened. He was unable to straighten his body. He suffered constantly from diarrhea, which yielded only to large doses of laudanum. Up to the end of 1890 he was frequently treated in the hospital, and at that time was discharged with 25 % insurance allowance. He afterward resumed his trade, but on July 2, 1897, he again fell from a height, and died on the following day.

The spine is generally fixed on movement of the body, giving the patient a stiff appearance. Stooping is often performed by bending the knees, while the spine is held fixed and rather straight, the patient straightening himself up by placing his hands on the thighs. Even if the spine is flexed on stooping, the movement is usually very limited. The patient, as a rule, complains of weakness, of a feeling of insecurity, and of pain on movement of the spine in any direction; the pain can often be localized by pressure on the spinous processes or by percussion of the spine. The pain may disappear in the course of time, or it may increase as the compressed intervertebral disc becomes absorbed. On lateral flexion of the body the spine is frequently found to be curved in the *opposite* direction at the point of injury; in rare instances, on the other hand, there is an abnormal degree of lateral mobility. The patients are often unable to walk without a cane. If the injury was complicated by lesions of the cord or by hemorrhages into its substance, the gait of the patient becomes spastic or ataxic. Paralyses of bladder and rectum are not infrequently met with, accompanied by albuminuria, etc., causing, in these severe cases, incon-

tinence of urine and feces or the opposite condition of retention. The reflexes may be diminished or lost, or they may be exaggerated. In case of unilateral lesion of the cord we find the patellar reflex diminished or lost on one side and exaggerated on the other. On the side on which it is lost the muscles are usually atrophied, while the skin is cool and insensitive to pain, deep pricks not being felt. The electric irritability may be only diminished, or the reaction of degeneration may be present. The electric irritability may, however, be restored for some time before the disturbances of sensibility pass off.

The prognosis of fractures of the vertebræ—more particularly of fractures of the body—is always grave. The prognosis as to life is very bad in serious cases complicated by lesion of the cord, most of the patients dying in the course of two years in consequence of complications. Less severe cases, not terminating fatally, are almost always followed by disturbances of function, as described under Symptomatology.

We do not need to give much attention to fractures of the laminae, since they very seldom occur alone. They are always very serious, because of probable injury of the cord; if the cord, however, escapes, fractures of the laminae are very difficult to diagnose.

Fractures of the transverse and articular processes have been referred to under Anatomicophysiologic Considerations.

Case of fracture of the lumbar vertebræ with fracture of several spinous processes, complicated by lesion of the cord. Sequel: recovery with angular curvature of the spine; full recovery of functional power.

A painter's apprentice, seventeen years of age, in 1869 fell from a scaffolding from twenty-five to thirty feet high, striking on his buttocks on a flight of stone steps. He was in the hospital for twenty-two weeks, lying on a water bed for eighteen weeks. There were paralysis of the lower extremities and disturbances of sensibility in the same; also paralysis of bladder and rectum. Three weeks after injury a bed-sore developed and persisted for four weeks. Fourteen weeks after injury the patient complained of a pricking sensation in

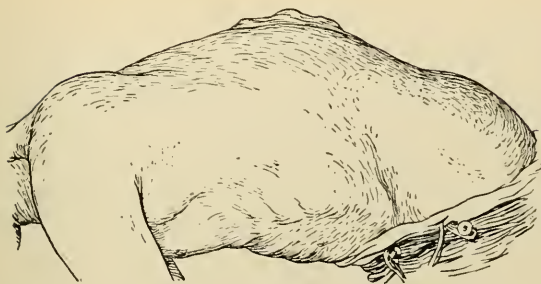


Fig. 19.



Fig. 18.



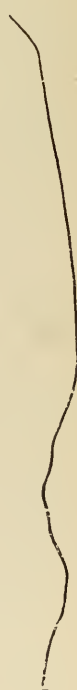
Fig. 20.



Fig. 21.



R
Fig. 22.



L
Fig. 23.

the lower extremities. The patient began to walk on crutches nineteen weeks after the injury. Nine months after the injury he resumed light work, and was able to do his full amount of work in two years.

The spine is markedly kyphotic in the lumbar region (Fig. 18), and the thorax appears pointed posteriorly. On anteflexion (Figs. 19 and 20) the spinous processes, which are thickened and further apart than normal, become more prominent. The outline of the spine on flexion is shown in the accompanying drawing. (Fig. 20.) On trying to bend backward (Fig. 21) the dorsolumbar region retains its kyphosis. On lateral flexion the kyphotic part of the spine is invariably curved in the opposite direction. Figure 22 shows the outline on flexion to the right; and figure 23 the outline on flexion to the left.

The patient has been perfectly able to work and has never suffered from any further symptoms of his accident twenty-nine years ago.

In respect to the after-treatment of spinal fractures, a long period of rest in bed is to be recommended, especially in consideration of the soft cancellous substance of the bodies of the vertebræ. If the patient is allowed to walk too soon, the weight of the body is apt to cause the formation of an angular spinal curvature, as described by Kümmel. As an additional precaution a supporting corset should be worn when the patient begins to walk about. Removable plaster supports are now made that do not interfere with treatment by massage and electricity. The other symptoms—limitation of spinal mobility, with difficulty of stooping—may be helped by massage and electricity as well as by medicomechanical exercises as soon as it is proper to employ the latter. The paralyses are best treated by galvanism, alternating with faradism. In some cases static electricity will be found very useful, especially if it is difficult for the patients to undress themselves, when the skin is sensitive to the air or to wet electrodes, or when they are especially susceptible to suggestive treatment. In other respects treatment is purely symptomatic.

In many cases the course of treatment must cover a very long period. In case of serious compression-fractures one year of treatment is to be anticipated, although recovery may take place sooner. The patient, however, may be able to resume work in a comparatively short

time, even in severe cases. We must bear in mind that in cases of compression-fracture there is always an extensive growth of callus and at the same time considerable absorption of bone tissue, and that, in addition, the intervertebral discs that were injured at the time of fracture usually undergo complete atrophy. It may happen, for these reasons, that an angular curvature is developed some time after the accident: in many cases, after the lapse of some years.

Fracture of a vertebra may give rise to so few symptoms that it is overlooked in the presence of other more striking injuries. Wagner and Stolper describe a case in which the spinal fracture accompanied fracture of the base of the skull, concussion of the brain, and fracture of the thigh. It was not discovered until three days after the accident, when the patient complained of pain in his back. I have known of cases of spinal fracture that occurred in conjunction with other injuries and that were overlooked, in spite of a long stay in the hospital, for the reason that the cord was uninjured and the patient made no complaint. Such fractures are especially likely to be undiscovered if, after the accident, the patient is able to walk to his home or to the doctor's office. Reference to cases of this description can be found in the works of Wagner and Stolper.

Case of fracture of the lumbar vertebræ, complicated by a unilateral lesion of the cord. Sequel: recovery, with paralysis of the right lower extremity, myelitis, cystitis, and nephritis.

A workman, thirty-three years of age, as he was engaged in pulling down a wall, on August 6, 1895, was hit on the back by a number of falling stones, being in a stooping position at the time. He was knocked down and could not arise again. He was treated in the hospital until March 22, 1896. He suffered from paralysis of the bladder and rectum, bloody urine, and retention, alternating with incontinence of urine. I examined him on April 9th. He was a rather large man, pale and sickly in appearance; he walked with difficulty, leaning on two canes. There was a very slight kyphosis of the lumbar region. Both legs showed atrophy, the right being much more affected. On walking, the right leg was swung forward from the hip, the patient being unable to lift it. The muscles of the left buttock appeared very flabby; a suppurating bed-sore still persisted in the neigh-

PLATE 9.

Case of Fracture of a Lumbar Vertebra Following a Slight Injury.—Sequel, tuberculosis of the lumbar vertebræ. Kyphosis marked. Death occurred seven years later from tuberculosis of the brain.

A mason, thirty-five years of age, on attempting to lift a box of lime felt something "crack" in his back, and had to stop work on account of pain. Three months later I examined him and found the condition here illustrated. He walked with difficulty. No paralyses.

One year after injury : paralysis of extremities and beginning disturbances of speech.

borhood of the anus. The ribs felt thickened on the right side of the back under the scapula. There were no cardiac murmurs ; pulse, 100. The patellar reflex was abolished on the right side, diminished on the left. The temperature was raised. The urine contained considerable albumin ; there was a purulent cystitis. He entered the hospital. I again examined the patient September 7, 1899 ; except in respect to the cystitis, which was cured, there was no change in his condition. Insurance allowance, 100 %.

Case of healed fracture of the lumbar vertebræ, complicated by lesion of the cord. Death occurred from diabetes mellitus after five years.

A carpenter, twenty-nine years of age, fell from a scaffolding September 17, 1888. He was treated in the hospital up to December 20, 1888. He was a man of moderate height. At the level of the first and second lumbar vertebræ there was a slight but distinct angular curvature. Other symptoms were sensitiveness to pressure, difficulty of motion, inability to stoop, and paresthesia of the lower extremities ; the patellar reflex was exaggerated on the right side ; there was incontinence of urine and of feces. The patient gradually grew worse, and died October 13, 1893, of diabetes.

In the majority of cases of healed fractures there is a considerable degree of incapacity for self-support ; in my own cases $33\frac{1}{3}$ to 50 % insurance was usually allowed. Fully one-third of all cases received 100 %. Nevertheless, we sometimes meet with cases of severe injury in which the victim, although outwardly changed in consequence, is able to resume work in a comparatively short time.

Traumatic Diseases of the Spine and the Spinal Cord.

Tuberculosis (Caries) of the Spine.—The spine in both children and adults is a favorite seat for the develop-



ment of tuberculosis, the cancellous tissue of the bodies of the vertebræ being especially subject to attack.

We are not concerned here with frank cases of spinal tuberculosis, but rather with the latent form of the disease as it exists in apparently healthy individuals, who are able to do their regular work until some accident occurs as a result of which the latent process is stirred to activity, permanently incapacitating the affected person for self-support. The traumatism may take the form of a contusion, a sprain, or a dislocation, or it may be so slight as scarcely to be considered an injury at all. The traumatism frequently results in the fracture of a vertebra, leading to an inflammation of the cancellous tissue and the fibrocartilaginous discs, which subsequently become suppurative; or the process may be partly reversed, inflammation, suppuration, and fracture being the order of sequence. The final result is the development of an angular curvature of the spine, which is characteristic of the disease under consideration. The two cases illustrated in this section (Figs. 7 and 8 and Plate 9) show this deformity very plainly.

Tuberculous vertebræ are exceedingly fragile, a condition that must necessarily affect the spinal meninges, the nerve-roots, and, lastly, the spinal cord itself. Persons affected with spinal tuberculosis that has developed in consequence of traumatism are regarded as entitled to insurance.

Infectious inflammatory processes of other kinds, of which traumatism may act as the exciting cause,—osteomyelitis and actinomycesis, for example,—may be considered to belong to this group of spinal diseases, of which tuberculosis is the most prominent member.

The Influence of Traumatism on the Development of Tumors of the Spine.—*Sarcomata* and *carcinomata* may develop secondarily in the spine as a result of metastasis from a primary growth in another part of the body, and of this secondary development traumatism may be

the exciting cause. In some cases primary sarcomata, carcinomata, and myomata are said to have developed in consequence of traumatism.

The tumor involves the vertebræ, their processes, the nerve-roots, and, finally, the cord and its meninges. The bone becomes exceedingly fragile, and slight injuries are likely to lead to fractures, causing lesions of the cord and, consequently, paralyses. In other cases the fragments become displaced gradually, compressing the cord slowly but surely.

The relation of the traumatism to the tumor-growth is clear if symptoms begin to appear at once. In the early stages sensitiveness to pressure and pain on movement are the only signs of the trouble ; later on, localized inflammation and the growth of a tumor can be determined, followed in turn by spinal curvature and paralyses, and finally by cachexia.

Traumatic Diseases of the Spinal Meninges.

The secondary affections of the spinal meninges that concern us here have been referred to in the beginning of this section. Two forms of chronic inflammation remain to be discussed :

1. Hypertrophic cervical pachymeningitis.
2. Chronic syphilitic meningomyelitis.

1. The lesion consists of a layer-like growth of fibrous tissue in the dura mater, by which it is greatly thickened. Adhesions are formed with the periosteum on one hand and with the cord and nerve-roots on the other ; the lower part of the cervical cord gradually becomes compressed. As a result of this compression we have the following characteristic symptoms : Pain in the neck and between the shoulders and in the back of the head ; rigidity of the neck ; sensitiveness to pressure over the cervical vertebræ ; neuritis affecting the ulnar and median nerves ; paresthesias : degenerative paralyses of the small muscles of the hand and of the flexors of the fingers ; contractures and

overextension of the wrists, due to the unbalanced action of the extensors.

The affection may follow traumatism or other causes, such as strains, exposure to cold, syphilis, and chronic alcoholism.

2. Chronic syphilitic meningomyelitis is, as its name indicates, a specific syphilitic disease of the cord and its meninges, and, therefore, a description is not in place here. Its development, however, is said to be called forth by exposure to cold and by traumatism.

Compression Myelitis.

By the term compression myelitis we understand an inflammation of the spinal cord caused by pressure from the bones displaced in consequence of dislocation or fracture of the vertebræ. The inflammation, which is chronic in nature, may also be caused by hemorrhage, and is frequently observed in cases of carcinoma and caries. The symptoms are as follows: neuralgic pains in the spine, girdle sensation, pains radiating toward the extremities. In addition, there are special symptoms, varying with the level at which the lesion occurs. The dorsal region is most frequently involved. Lesions here are followed by a spastic paraplegia of the lower extremities, disturbances of sensation, bladder disorders, etc. If only one side of the cord is affected, we have the symptoms described by Brown-Séquard.

The prognosis is grave, death usually occurring in the course of one or two years, from cystitis, nephritis, bed-sores, or some other complication. The inflammation may spread in a transverse diameter, giving rise to a myelitis transversa, or it attacks different places in the cord and becomes a myelitis disseminata. The symptoms correspond to those described in the beginning of this section in regard to the pathology of the spinal cord.

Secondary Degeneration.

When, in consequence of traumatism, nerve-fibers are severed from their trophic centers, they undergo degeneration, which may take a descending or an ascending course according to the position of the centers, whether central or peripheral. In the case cited by Wagner and Stolper the fifth dorsal vertebra was the seat of a carcinoma :

The patient, a man forty-six years of age, had recovered one month previously from a pleurisy from which he had suffered for six months, when he was again taken to the hospital for tumor of the ribs. Three days later there was paralysis of sensation in both lower extremities, especially in the right one. Two days later the paralysis of sensation had extended upward as far as the seventh rib. Motor paralysis of the lower extremities was manifested soon afterward, with retention of urine, constipation, and cystitis. Death occurred in forty-four days.

Traumatic Inflammation of the Neuroglia and Traumatic Syringomyelia.

As a result of injuries of the cord a growth of cicatricial tissue takes place, involving the supporting framework—the neuroglia—as well as the connective tissue of the blood-vessels. This hyperplasia of the neuroglia may be based on a congenital tendency. It is often the precursor of destruction of the cord-substance and of cavity formation—syringomyelia. Syringomyelia may also be directly caused by traumatism. It is most frequently found in the cervical region.

According to Wagner and Stolper, the following points are of assistance in determining the traumatic origin of syringomyelia :

1. Signs of a healed fracture or dislocation found in the vertebræ point to traumatism. During life kyphosis is frequently seen, while scoliosis is more characteristic of the nontraumatic form.

2. Traumatic syringomyelia is most frequently seen in the regions especially subject to fracture : *i. e.*, the lower dorsal and lumbar regions ; the nontraumatic form is more likely to occur in the cervical region.

3. In traumatic syringomyelia we are likely to find adhesions and hypertrophy of the meninges, both with each other and with the wall of the vertebral canal. Some exogenous cause is likely to be discovered, whereas in the nontraumatic form of syringomyelia, which develops as the result of a central hyperplasia or destruction of the neuroglia, this is not the case. For the same reason we find a proliferation of the pia mater in the one case, but not in the other.

4. In traumatic cases the cavity is likely to be situated in the posterior columns; otherwise it is found only in the anterior horns; in the nontraumatic form the posterior commissure is the favorite site.

5. In the traumatic form blood-pigment is often found; its presence can not be explained on the ground of idiopathic affection of the blood-vessels, which is, as a rule, seen in connection with the nontraumatic form.

An ascending neuritis, occurring in consequence of a peripheral injury, is said in some cases to be followed by syringomyelia.

Symptoms.—*Localized Symptoms:*

[We are hardly in a position as yet to speak of traumatic syringomyelia. There are two possibilities. One is that a trauma, by causing hemorrhage into central gray matter that is already diseased, calls forth into activity a latent myelosyringosis. The other possibility is that central hematomyelia, as described in the note on page 135, may cause permanent symptoms similar to those of syringomyelia. But neither possibility would justify the term "traumatic syringomyelia." For, in the first, the trauma would be merely a contributory cause; and the second, while it might in its symptomatology be identical with syringomyelia, would be so different in pathogenesis that nothing would be gained by giving it the name of a chronic progressive disease when its own name of traumatic hematomyelia so well describes it.—ED.]

1. Progressive paralysis and muscular atrophy, in-

volving one or both sides. In nontraumatic cases the upper extremities are especially involved. The atrophy is of the degenerative type; fibrillary spasms can be observed, and the electric reaction is that of degeneration.

2. Disturbances of sensation. The tactile sense remains unaffected, while analgesia and thermal anesthesia are manifested; burns are not felt.

3. Trophic disturbances of the fingers, of the feet, and of the corresponding joints, and of the nails; contractures and rigidities; formation of ulcers.

4. Paralysis of the bladder and rectum, impotence, etc.

Case of syringomyelia following cellulitis of the forearm and ascending neuritis.

A workman, twenty-nine years of age (alcoholic), was injured in his left forearm near the elbow-joint by the penetration of a piece of wire, on August 9, 1895. His arm was treated for one week with wet dressings, incision then being practised on account of marked swelling and fever. I examined the patient November 9, 1895. His left elbow was fixed in a position of slight flexion; the scar on its extensor surface was not quite healed and was still suppurating. The left arm was considerably wasted, especially the hand.

Treatment was first directed to the wound; then to the contracture of the joint.

Neuritic symptoms gradually manifested themselves, at first in the forearm, then ascending as far as the shoulder. The whole arm was the seat of severe pain, which also extended to the shoulder and to the whole left side of the throat and neck. There was pain on motion of the head and on attempts to raise the arm; also tremor in arm and hand. The patient closed his hand with great difficulty, and was unable to grasp anything tightly. Atrophy of the nails began to appear, and the distal phalanges showed signs of stiffness, while the muscles of the hand were greatly wasted. There were, in addition, thermal anesthesia, necrotic ulcers on the fingers, tremor of the facial muscles on the left side, marked dilatation of both pupils, and diminution of the pupillary reflex. Insurance allowance, 60%.

In multiple sclerosis we have another disease giving localized symptoms, in which sclerotic patches are found scattered through both the brain and the cord; it is observed as a sequel of either central or peripheral traumatism. The symptoms are somewhat variable, as may be expected from the irregular distribution of the

lesion. They include : Disturbances of speech ; a slow, scanning, and monotonous manner of speaking ; nystagmus ; exaggerated reflexes ; spastic and ataxic gait ; intention tremor ; and uncertain, exaggerated movements. The treatment is symptomatic.

Chronic Progressive Anterior Poliomyelitis.

Disease of the anterior horns may be due to injuries and diseases of the central nervous system, or it may follow an ascending neuritis. The muscles supplied by the diseased parts undergo atrophy, but respond to the will as long as any muscle-fibers are left. The reflexes are diminished but not abolished. The application of cold to the skin (sometimes blowing on it will suffice) induces slight spasms in the affected muscles, involving only separate bundles or fibers, which are to be looked upon, according to Leube, as pathologic reflex contractions (Thiem).

The skin of the affected region is reddened or bluish-red, and occasionally shows a vesicular eruption. A certain amount of improvement may take place ; the prognosis, therefore, is not entirely unfavorable.

Spastic Paraplegia.

[In many of the cases to which this clinical term is given the underlying lesion is probably multiple sclerosis.—ED.]

In this affection of the cord, which may follow either central or peripheral lesions, the lateral pyramidal tracts are involved. We have, therefore, the following symptoms : exaggerated reflexes and diminished muscular power, without atrophy or degeneration.

If in the course of time the process extends to and involves the anterior horns, atrophy will, of course, result. The first symptoms to be manifested are weakness and atrophy of the muscles of the hand. The spastic paresis characterizing the gait is seldom noticeable until some time later. The atrophy extends upward to the shoul-

der; the muscles soon show fibrillary contractions and the reaction of degeneration, while the reflexes become exaggerated. The patellar reflex is likewise affected; foot-clonus and bulbar symptoms also develop.

Tabes Dorsalis ; Locomotor Ataxia.

[Much the same difficulty as was described for general paresis is met with in the attempt to fix a traumatic causation for locomotor ataxia. Tabes is very insidious in its onset, and most of the early symptoms are of a character that no one but the physician familiar with nervous diseases would recognize. There is no room for doubt that injuries often first bring the disease to the notice of the patient, or that through injury it becomes very much worse. But to show that an injury is the sole cause of it, in the sense that without the injury the disease would not have occurred, will rarely be possible.—ED.]

As a result of traumatism this disease, which may have been in existence for a number of years without noticeable manifestation, is suddenly awakened into activity and makes rapid progress in its development. Since marked tabetic symptoms in such cases do not appear until after the injury, the term "traumatic tabes" is not altogether out of place. The cases referred to later are interesting in this connection, no tabetic symptoms whatever having been manifested, or at least noticed, previous to injury.

The exciting traumatism may act either centrally or peripherally.

Instances of central injuries are: hemorrhages into the substance of the cord (from concussion of the cord (?)), contusions, and dislocations or fractures of the spine involving lesion of the cord. To the peripheral causes belong: sprains, dislocations, and fractures of the ankle-joint or of any part of the lower extremity, severe contusions, and phlegmonous inflammations.

The patient need not be completely incapacitated for self-support, even in cases presenting definite tabetic symp-

toms; complete incapacity is not to be recognized until the symptoms become quite marked and until the characteristic gait is well developed.

The most important symptoms are: (1) Loss of pupil reflex; (2) loss of patellar reflex; (3) ataxia (uncertain, stamping gait; unsteadiness on closing the eyes).

The disease is further characterized in its different stages by paralytic disturbances of sensation and of the functions of the bladder, severe pains, vomiting, cough, difficulty in breathing, ocular paralysis, etc.

In respect to treatment, some improvement may be gained from antisyphilitic remedies, the underlying cause of the disease being specific in the majority of cases. Gymnastic treatment has been highly praised in the last few years; baths and nerve tonics may also prove beneficial. Recovery is, however, out of the question; the progress of the disease can not be arrested.

The arthropathies seen in cases of tabes have already been referred to in the first part of the book.

Case of locomotor ataxia following "concussion of the spinal cord."

A carpenter, fifty-two years of age, fell from a building on November 14, 1891, striking on his back. He was first treated at home by his lodge physician, and by him sent to a nerve specialist, who treated him for "lumbago." He was next cared for at home by a doctor who found him in bed with fever and made a diagnosis of "influenza." The physician into whose charge he next fell diagnosed pulmonary phthisis. Finally, in the hospital, a diagnosis was made of incipient tabes, based on the following symptoms: loss of pupillary reflex (pupils much contracted), marked swaying of the body on closure of the eyes, and loss of the patellar reflexes.

I examined the patient February 19, 1892. He was a small, pale-faced man. In addition to the symptoms mentioned, he frequently suffered from incontinence of urine and from diarrhea. He declares that he was always well prior to his accident. His condition has remained unchanged up to date. Insurance allowance, 100%.

Case of locomotor ataxia following a sprained ankle.

A mason, thirty-nine years of age, sprang from a scaffolding on November 4, 1893, in order to save himself from a severe accident that would otherwise have followed a misstep. He landed with his right foot on a stone slab, striking his head against a wall. He immediately passed a large quantity of urine. He was taken home, where he lay in bed and was treated for a sprained ankle. Four weeks later he attempted to walk, and his peculiar gait was at once noticed by his

family. The doctor diagnosed the case as one of tabes. The patient is said to have previously suffered from syphilis.

I examined him February 26, 1894, and made the following diagnosis: locomotor ataxia following peripheral traumatism, consisting of a sprain of the right ankle. Arthropathy of the right foot. Insurance allowance, 100%. No change in his condition up to date.

Case of preexisting locomotor ataxia, the progress of which was greatly accelerated by fracture of the leg, caused by a misstep upon a sharp stone. Sequel, complete incapacity for self-support.

A mason, forty-six years of age, stepped on a sharp stone on January 20, 1897 causing his leg to give way and throwing him to the ground. A fracture of the left leg was diagnosed and appropriate treatment was begun.

I examined him March 6, 1897. He was a man of medium height and vigorous build; his gait was markedly ataxic. The pupils were small and did not react; patellar reflexes were lost. On closing his eyes, even when sitting, there was marked swaying of the body. Diagnosis, locomotor ataxia. The patient had had syphilis twenty years earlier; he was married, but had no children. In 1896 he had suffered from "rheumatism" in his arms and legs for eight weeks. At that time he began to notice unsteadiness of gait, but was able to work, even on scaffoldings. Since his accident he has been completely incapacitated for self-support. His insurance allowance equaled 33 $\frac{1}{3}$ % at first; later, it was raised to 66 $\frac{2}{3}$ % by legal process. The fact of the preexistence of the disease was taken into consideration.

Cases of **paralysis agitans** can occasionally be traced directly to an injury; the case of my own given later is an instance of such relation. The affection, which is peculiar to middle and old age, presents characteristic symptoms. The patient holds his body bent forward in a crouching posture, while one forearm is in a state of constant tremor. The tremor ceases during sleep or when the patient is resting quietly, but is induced and increased by excitement. There may be a temporary lull in the symptoms, simulating an improvement. By reason of the age of the patients they are usually rendered incapable of self-support.

Case of paralysis agitans following fracture of the ribs and contusion of the spine.

On October 24, 1888, a workman, sixty years of age, slipped and fell to the ground, striking his back against the edge of a wheelbarrow. Four weeks later, when union had taken place in the broken ribs, he noticed the first symptoms of nervous disease, which I diagnosed as paralysis agitans on January 18, 1889. The traumatic etiology was recognized, and 100% insurance was allowed. The condition of the patient has remained unchanged.

Spinal Irritability ; Spinal Neurasthenia.

The classic researches of Wagner and Stolper have cast a doubt upon the traumatic origin of this affection, and, indeed, upon its very existence. The symptoms that have been considered to belong to it—pain in the back and loins, sensitiveness to pressure on the spine, exaggerated reflexes—may in reality be the forerunners of serious disorders of later development. If not, they may be looked upon as symptoms of the functional neuroses. In the two cases of Leyden and Schäffer cited by Thiem there was a subsequent development of tuberculosis.

[This is contrary to the teachings and experiences of most neurologists. Traumatic neurasthenia is generally accepted as the best name for certain types of nervous exhaustion that are frequently the results of accidents. In such cases no evidences of gross structural injury to the central nervous system are apparent or ever become so. The symptoms are almost identical with those of neurasthenia in which injury has had no part.—ED.]

Case of traumatic neurasthenia following contusion of the spine.

A man, thirty-nine years of age, was hit in the back by the pole of an omnibus on January 25, 1893. He was treated in a dispensary for four weeks, then in the hospital for two weeks, when clinical treatment was resumed. He attempted to work, but was obliged to stop on account of pain in the back. He has not worked since April 27, 1893. He is a large man of moderately vigorous build.

Symptoms.—Depressed expression ; easily moved to tears ; restlessness ; insomnia ; dilated pupils, which react slowly. The spine was sensitive to pressure throughout its length, and especially in the dorsal region ; it was fixed on every attempt at motion. The reflexes were exaggerated ; there were no sensory disturbances. Examination did not give definite results. The gait was somewhat dragging. The patient's condition has remained unchanged up to date. He lies abed much of the time, and can not be induced to attempt to work.

Case of traumatic neurasthenia of a hypochondriacal character following a fall from a height. (Simulation suspected.)

A roofer, twenty-eight years of age, fell from the roof of a five-story house on October 11, 1889. He suffered a slight concussion of the brain, a number of contusion-wounds, and a sprain of the right ankle. He was treated at home, lying in bed for four weeks. I examined him January 15, 1890. He was quite a large, powerful man,

of rather pale complexion. His expression was depressed, but at the same time surly and defiant. Physical examination was complained of as exceedingly painful, and was in part not permitted. There seemed little basis for the innumerable complaints of the patient. Although he declared himself to be unable to do work of any kind, he is known to have worked as a roofer, receiving full pay. He was consequently declared to be capable of self-support, but subsequently was allowed 25% insurance by the court.

Case of traumatic hysteria of a hypochondriacal character following contusion of the spine.

A mason, forty-two years of age, was struck on the back by a heavy stone, which fell from the third story, on April 18, 1887. He felt faint and discontinued work. He was treated for ten days in the hospital, and was then discharged, on his own request, as cured.

I examined him on July 19, 1887. He was a large, rather vigorously built man. He held his body somewhat inclined forward; his expression was depressed, and his eyes had a somewhat staring, vacant look. The facial muscles were noticeably unmoved when he spoke. The spine was sensitive to pressure and was fixed on motion of the body; the cutaneous reflexes and tendon-reflexes of the lower extremities were exaggerated; there was a tremor in the latter and muscular weakness in the arms. Sensation was diminished in the right leg and in both forearms; there was anesthesia to pain in the same parts. The pulse was exceedingly rapid. The patient complained of a feeling of oppression and of melancholy.

His subsequent conduct has given cause for much displeasure; he writes threatening and complaining letters to his trades-union, and considers that he is badly treated by everybody. Insurance allowance, 100%. He has done no work since his accident.

Contusion and Crushing of the Back.

In preparing the following I have made use of seventy-eight cases of injuries of the back that have come under my own observation.

Contusions of the back caused by falls, kicks, or blows from falling objects usually give no trouble after the hemorrhagic extravasations have been absorbed and the pain has disappeared. Individuals thus injured may not find it necessary to interrupt their work at all, and in any case resume it, as a rule, within two to three weeks. Severe cases of crushing, such as are seen after the caving-in of buildings, demand a longer course of treatment, and are followed by a limitation of mobility of the body, affecting the patient for a considerable period. All such cases should be examined with the greatest care, or else an injury of the spine may be overlooked.

Wounds and Cicatrices of the Back.

Movement of the body may be noticeably limited by the cicatrices that follow extensive wounds of the back. Stooping, for instance, is made difficult for some time by scars in the region of the long extensor muscles of the back. Treatment should be directed chiefly toward obtaining a nonadherent, movable scar.

Case of a cicatrix adherent to the twelfth rib on the left side, consequent upon a punctured wound of the back, complicated by lesion of the kidney.

A carpenter was injured on August 23, 1898, by a chisel, which penetrated his back on throwing his sack of tools over his shoulder. The lesion involved the left kidney. He was operated upon in the hospital, where he remained for three weeks.

I examined him on December 19, 1898, and found the kidneys normal. In the region of the left kidney there was a scar, of recent origin, and about 10 cm. in length, which ran obliquely across the back. It was attached to the twelfth rib and was adherent throughout; on stooping, the scar became very tense, and prevented deep flexion or flexion to the right side. The muscles of the left side of the back were atrophied. Insurance allowance, 20%.

On May 10, 1898, the scar was found to be paler, nonadherent, and freely movable. He was able to stoop with ease, and could pursue his trade without difficulty. He showed evidences of attempted simulation.

Burns of the back lead to the growth of more or less extensive scars, according to the size and intensity of the lesion. When recent, these scars limit mobility to a considerable degree. The patients, as a rule, recover full capacity for self-support. Severe cases, however, necessitate treatment for a long period.

Strains and Lacerations of Muscles and Tendons.

Under this title are described various painful affections of the back, usually of traumatic origin, the pains dating from the time of accident.

It is quite possible for laceration of muscle-fibers to take place as a result of carrying heavy loads, of awkward movements, of carrying a load on one shoulder, or even of falling on the back on rough ground. There may be almost no external sign of injury, yet the pain may be

very severe. Sometimes the painful point is found to be swollen. In the cases marked by persistent pain, in the absence of swelling a very thorough examination is indicated, in view of a possible injury to the spine, such as fracture of one or more of the processes or lacerations of the ligaments.

In all cases of so-called *traumatic lumbago* examination of the urine for phosphates is strongly to be recommended, since phosphaturia frequently causes the symptoms of lumbago. It is undoubtedly a fact that lumbago may develop after traumatism, giving rise to the pains, commonly of a rheumatic nature, that suddenly attack the patient in the shape of a "crick in the back." The same symptoms may be due to direct contusions of the sensory spinal nerves or of their roots. The pains in the loins may be so severe as almost to prevent the patient from moving. In less severe cases the fixation of the spine, giving a stiff appearance to the patient, is very noticeable; also the inability to stoop or to rise from a sitting posture without the aid of the hands. Reference has already been made to the sprains of the articular processes of the fifth lumbar vertebra, which are momentarily forced into the lumbosacral fossa. The lifting of heavy weights sometimes gives rise to symptoms that are indicative of a lesion of the ligaments in this situation, and that are entirely similar to those of lumbago.

Subcutaneous rupture of muscles has been observed in the long muscles of the back, in the erector spinæ and also in the latissimus dorsi. The cause of this injury is not definitely understood. In the cases that I have seen in which the erector spinæ was ruptured by a fall on the back the point of rupture was plainly visible. The lower part of the muscle had retracted, forming a thick roll, while the overlying muscles were distinctly atrophied. Stooping was painful at first, but was easily accomplished later on. In one case, in which the muscle was ruptured on both sides, a depression could be plainly felt running

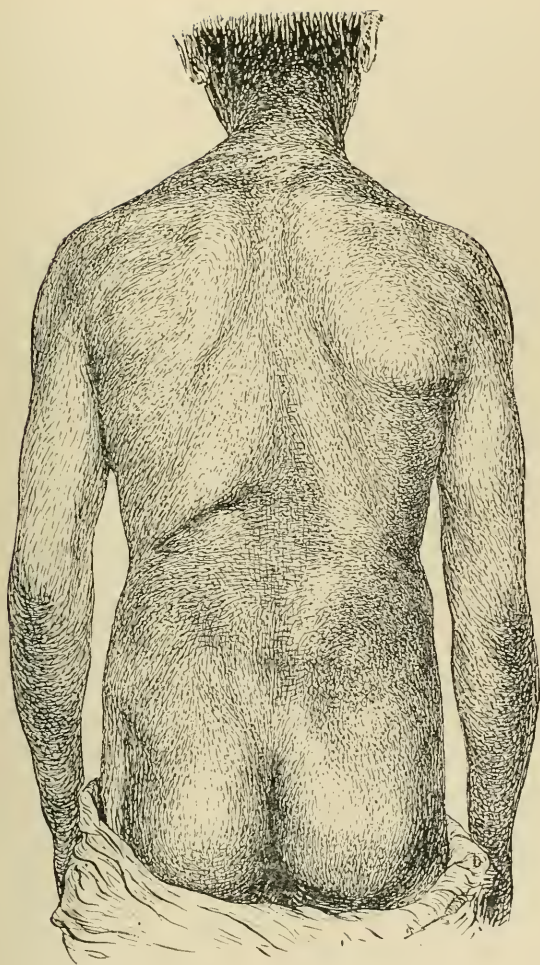


Fig. 24.

almost transversely across the back. Stooping was so painful that it was not attempted at first, but improvement was evident at the end of two months. The insurance allowance in this case was 20 %. In a case of rupture of the latissimus dorsi cited by Thiem it was very difficult for the patient to raise his arm or to place it behind his back. He recovered, however, by the use of baths, massage, and electricity.

III. INJURIES AND TRAUMATIC DISEASES OF THE CHEST.

Anatomicophysiology Considerations.—Deformities of the thorax, apart from congenital abnormalities or those acquired through disease, are often observed in workmen as the result of special forms of work. Reference has already been made to the exaggerated convexity of that side of the thorax on which the load is carried as part of the deformity characterizing stone-carriers. In addition to the convexity, the ribs are usually separated on that side, while on the other the thorax is depressed and the ribs are approximated. The shape of the thorax may also undergo modification in consequence of a regularly maintained position of the body. In examining patients these facts should always be borne in mind or serious errors may result.

Although familiarity with all the deformities due to work in the various branches of industry is hardly possible, we should, nevertheless, make detailed inquiry into the employment of the patient, in order that a differential diagnosis between deformities incidental to such employment and the sequels of traumatism may be made. If we watch the thorax during respiration and during movements of the body,—flexion, extension, and rotation,—we can observe differences in the action of the ribs on the two sides.

A few words in respect to the term *chest* as understood by workmen will not be out of place here. It is used by them to describe not only the anterior bony wall of the thorax, but also the adjacent part of the abdomen. It is, indeed, almost impossible to draw a sharp line between the two regions externally, since a not inconsiderable part of the abdominal organs are contained in the thorax. A special section being devoted to injuries of the former, they will be left out of consideration in discussing those of the chest, and will be referred to only when absolutely necessary. The thoracic and abdominal cavities, although divided by the diaphragm, bear a very close and interdependent relation to each other, as we know from a study of their anatomy and physiology.

The relation of the thorax to the upper extremities is also extremely important in regard to the effects of traumatism. Injury of the mus-

cles of the thorax or of the arm may seriously hamper the functional action of other parts, or even disable them altogether. The mutual interdependence of the different regions of the body and their relations with neighboring organs should always be kept in mind in dealing with accident-cases.

My material embraces 426 cases of injury of the thorax—227 cases of contusions, 184 of fracture of the ribs, and 15 of internal injuries.

CONTUSIONS OF THE THORAX.

In the majority of cases slight contusions of the wall of the thorax, caused by falls, kicks, or blows, heal rapidly and without sequels, necessitating only a day or two of rest. Some of the patients simply have a few cups applied and resume work on the following day. The symptoms may, however, persist somewhat longer, involving a course of treatment of several weeks' duration. Severe contusions, on the other hand, or even slight injuries to individuals suffering from an affection of the lungs, cause disturbances that may persist for some months, or even longer, in spite of treatment.

Symptoms.—Pains in the chest, which are often difficult to locate with exactness, dyspnea, palpitation of the heart, weakness, inability to stoop or to lift weights, frequency of anorexia, etc.

On examination we may find affections of the pleura (dullness, diminished respiratory sounds, friction-sounds, more or less circumscribed tenderness) or of the lungs (traumatic pneumonia); also affections of the pericardium or of the cardiac muscle, of the stomach, or of the liver. We may find, in short, a number of morbid conditions that were not noticed at first, since their onset was gradual, but that were made evident and aggravated by a too early resumption of work. We shall refer again to these symptoms.

Since severe contusions may cause laceration of the thoracic organs, it is only to be expected that similar but more severe lesions should occur in the peculiar cases of crushing of the thorax with which we meet in patients

PLATE 10.

FIG. 1.—Case of Compound Fracture of the Sternum and the First Rib on the Left Side. Sequel, complete recovery except for slightly diminished capacity for self-support.

The illustration shows the scar on the sternum. The patient was a stone-carrier, forty-five years of age, who, on October 7, 1892, was injured by the breaking of his hod, being knocked down and struck on the chest by the stones that the hod contained. He was treated in the hospital for three months, the fractured bone being united by sutures. I examined him March 6, 1893. He was a large, vigorous man. On deep respiration he complained of pain. For a short time he was treated in my hospital by mechanical methods (chest-expansion), and was then discharged with an insurance allowance of 15%, later increased to 25%. He does not consider himself able to carry stones.

FIG. 2.—Case of Ununited Indirect Fracture of the Seventh Rib on the Left Side. The working-capacity is relatively good.

The illustration shows a small, round tumor on the seventh rib, close to the mammillary line. It does not protrude sharply. A man, forty years of age, fell from a ladder on December 30, 1897, striking on his right hip. He at once felt pain in the left side of the chest, and remained in bed for four weeks, being treated by plaster strips and compresses. I examined him March 24, 1898. He complained of stabbing pain in the left side of the chest and of dyspnea on climbing stairs. I found a small, round, fairly movable tumor on the seventh rib on the left side, filling the space between that and the sixth rib. It was still red in appearance. Pressure on the fractured segments of the bone produced crepitation. The tumor was pushed forward on coughing. On auscultation there were slight dullness and a few pleuritic friction-sounds. The insurance allowance was fixed at 20%, in view of the fact that he was able to work at full wages. He was subsequently allowed 33½% by the court, which allowance was reduced four months later to 20%.

who have been run over or caught between car-buffers, or under falling walls, heavy beams, and the like. Such injuries often produce fractures, but it not infrequently happens, especially in young and healthy individuals, that the thorax is crushed in without breaking a single rib. The internal organs are almost always lacerated in such cases, and death is liable to occur immediately or very soon afterward. When the injury does not terminate fatally, it frequently leads to affections of the lacerated organs, and the patient is, in consequence, partly or wholly incapacitated for self-support.



Fig. 1



Fig. 2





Fig. 25.

Case of fracture and crushing of several ribs on the right side. Sequel, perfect recovery.

A coachman, forty-six years of age, was thrown from the seat of his carriage on January 4, 1898, the hind wheel passing over his chest. On examination a definite diagnosis of fracture could be made only in respect to the seventh rib on the right side. On February 7, 1898, examination showed a fibrous pleurisy of the right side. He was allowed 30% insurance. On March 8, 1899, he was declared to be perfectly capable of self-support.

Case of severe crushing of the right side of the thorax and right shoulder, complicated by fracture of the ribs and injury of the lung. Sequels: pulmonary tuberculosis and complete paralysis of the right arm, right shoulder, and right side of the thorax.

A man, twenty-seven years of age, was caught under a falling building, sustaining the foregoing injuries. The injury of the lung was at once followed by pneumonia, requiring treatment for a long time; later, tuberculosis is developed, but was brought to a standstill by treatment in a sanitarium. His right arm is completely paralyzed, and is cyanotic and cold; the right side of the thorax is also paralyzed; its expansion is restricted; no respiratory sounds are perceptible on that side, and the muscles of the right side of the chest and back are greatly atrophied. Insurance allowance, 100%.

FIG. 25.—*Case of severe crushing of the thorax and fracture of several ribs* (p. 189). Sequels: chronic pleurisy; death from tuberculosis.

A man, thirty-eight years of age, fell to the ground on June 4, 1896, in such a way as to cause his head, filled with lime, to strike on the left side of his chest. He was treated at home by means of compresses and medicine, lying in bed for eleven days. On November 6th he resumed work; on February 13, 1897, he was obliged to cease work again on account of pleurisy on the left side.

I examined him on February 17, 1897. He was a large man, but greatly wasted. The left side of the chest at the level of the fifth to the seventh ribs, inclusive, was deeply depressed. The respiratory sounds were diminished in intensity over the entire left side of the thorax, and at the area of depression they could not be heard. On inspiration the left side of the thorax expanded less than the right; movements of the thorax were difficult. A second examination, on June 2, 1897, showed dyspnea, cough, and loud rales over the left apex. The patient was exceedingly emaciated. He died of pulmonary tuberculosis on September 28, 1897.

COMMOTIO PECTORIS; CONCUSSION OF THE CHEST.

This lesion is caused by severe contusions, and is immediately followed by unconsciousness. In severe cases death may occur at once; if less seriously injured, the patient may recover from the shock and may regain his health in part or entirely. Permanent disturbances may,

however, result, such as very severe forms of hysteria, leading to complete incapacity for work, of which I have myself seen several instances.

Case of commotio pectoris, followed by severe hysteria, with frequent convulsions.

A mason, forty years of age, fell from a ladder on November 7, 1892, striking with his chest against a box of lime. He was unconscious for a time, but was afterward able to walk home, and after a few weeks of medical treatment resumed work. He soon found himself unable to continue work.

I examined him on February 6, 1893; he was a fairly large, vigorous man. From the beginning of the examination he was greatly excited; there was marked tremor of both arms and legs, first on one side, then on the other, accompanied by facial spasms and outbursts of weeping. Muscular spasms were induced by examination of the reflexes or by reference to the consequences of the accident. The pupils were contracted and reaction was slow on both sides. Psychically, he exhibited chronic hypochondriacal depression. The reflexes were greatly exaggerated. In testing the cremaster reflex on the left side spasms of the muscles of the left arm were immediately induced. The patient was completely incapacitated for self-support; his condition has remained unchanged up to date.

WOUNDS AND CICATRICES OF THE CHEST.

The degree of functional disability arising from cicatrices in this situation depends upon the size and location of the wound as well as upon its severity. If the cicatrix is extensive, deeply attached, and retracted, and especially if it is adherent to one or more ribs, considerable disability may result.

The usual symptoms consequent upon adhesions to the ribs are pain and a feeling of tension on deep inspiration, on lifting the arm on the affected side, and on flexion of the body away from the latter. The muscles often undergo considerable atrophy. Fistulas due to empyema usually heal with deep, circular, and much-retracted scars, which give rise to symptoms indicative of involvement of the diaphragm or the intercostal nerves. The symptoms gradually diminish, even without treatment. They can be overcome in a comparatively short time by means of mechanical treatment.

Cicatrices resulting from burns are more spread out and superficial, and do not cause functional disturbances unless greatly retracted; mechanical treatment—in particular massage, by which the scar-tissue is loosened and stretched—is also of great benefit in these cases.

Case of severe contusion and incised wound of the right side of the chest. Sequel, recovery, with extensive cicatricial growth and limitation of mobility of the right shoulder-joint.

A glazier, twenty-seven years of age, was caught between an overturned glass cupboard and a door on January 6, 1899. In addition to the severe contusion he sustained, he was pierced in the right side of the chest by the broken glass. He was treated in the hospital for five weeks.

I examined him on March 6, 1899, and found a number of scars adherent to the ribs on the right side of the chest; the muscles of the affected region were greatly atrophied, as were also those of the right arm. The latter could not be raised at the shoulder-joint to more than an angle of 95 degrees; the right elbow-joint showed a contracture of 160 degrees.

The right arm and the cicatrices were treated by massage. Mechanical exercises were also prescribed. On May 2d the patient was discharged from the clinic because of disobedience of orders. He was then able to raise his arm to an angle of 155 degrees, and the muscles had increased in size.

The pectoral muscles, both major and minor, may be ruptured subcutaneously by direct or indirect violence. The lesion occurs in cases of dislocation of the humerus and in fractures of the coracoid process. The subclavius muscle may suffer a similar injury as a result of fracture or dislocation of the clavicle or of fracture of the first rib. The muscles are, as a rule, only partly involved, but complete ruptures of the pectoral muscles are sometimes seen in patients who have been run over or caught under falling buildings, walls, etc. The remote symptoms of the lesion are a depression in the groove of Möhrenheim, atrophy of the muscles of the chest, shoulder, and arm, and limited mobility of the latter. Patients complain chiefly of pain and weakness in the arm. Rupture of the serratus magnus is sometimes caused by exercises on the horizontal bar. This muscle, as well as the intercostals, may also be partly ruptured in cases of fracture of the ribs.

Partial ruptures are best treated by exercises, baths, compresses, massage, and electricity. Complete rupture of the pectorales is followed by permanent functional disability.

Case of partial subcutaneous rupture of the pectoralis major. Sequel, improvement, with moderate degree of functional disability.

A mason, thirty-eight years of age, was engaged, together with several fellow-workmen, in moving an iron beam, on December 19, 1893, when, in consequence of the blunder of the others, who let go the beam too soon, he received a very violent and painful strain. In spite of pain in the right side of the chest he kept on with his work until December 23d. He treated himself for several days with compresses and innunctions, and began medical treatment on December 27th.

I examined him and received him into my hospital on June 11, 1894. He was a rather large, vigorous man. On the right side the chest showed atrophy, and there was a marked depression in the groove of Mohrenheim, indicating a partial rupture of the pectoralis major. The right deltoid, biceps, and trapezius were atrophied; the right arm could be raised only to an angle of 95 degrees. There were a tremor of the right arm and crepitation in the lower part of the cervical spine on movement of the head. The patient was discharged August 13, 1894, and was considered completely capable of self-support, there being only slight functional disability at this time. He was later allowed 20 % by the court, his symptoms having again increased.

Fractures of the sternum are unquestionably a rare form of injury. They may be caused by direct violence, such as blows from falling weights, crushing under falling walls, and similar accidents, or by indirect violence. The latter mode of occurrence is met with in cases of fracture of the bodies of the vertebræ from overflexion, and also in cases of similar lesions due to overextension.

It is apparent that direct fractures of the sternum involve greater danger than the indirect form, both in respect to immediate and remote consequences. Symptoms due to changes in the underlying organs that were injured at the time of accident may persist for a long time.

Compound fractures of the sternum are followed by cicatricial adhesions, which are likely to cause pain on vigorous movement of the body, on carrying loads, or with rapid respiration.

FRACTURE OF THE RIBS.

I have treated or examined 184 cases of this injury, of which the majority were due to direct violence. In a number of cases direct and indirect fractures occurred simultaneously.

In order to obtain a clear understanding of the sequels of fracture of the ribs it is imperative to keep the shape and position of these bones clearly in mind. Reference has already been made to the remarkable elasticity possessed by the ribs, by means of which they are able to endure great pressure without giving way. When the limit of this elasticity is passed, fracture occurs.

Direct fractures of the ribs are caused by kicks, by blows with a blunt instrument, or by falling and striking on the sharp edge of a wall, table, board, step, etc. The fracture occurs at the point at which the violence is applied, the fragments of bone being pressed inward while the angle of fracture lies externally. In some cases one of the fractured segments is displaced outward, subsequently forming a callous thickening. The same rib may simultaneously suffer an indirect fracture at another point.

The fracture may be complete or incomplete, depending upon the degree of violence, the structure of the ribs, and the age of the individual. Incomplete fractures are very frequently met with, and, as a rule, involve the internal surface of the rib, as is to be expected if we consider that the injury is usually caused by direct violence. The periosteum may remain intact, even if the rib is broken in several places.

Fractures of the rib are most often observed in individuals of advanced years. In youth the ribs possess a high degree of elasticity, while in old age they are liable to fracture from very slight causes. Complete fractures are produced by the same causes as incomplete fractures, the violence being only more severe. In complete fractures due to direct violence the periosteum, the parietal pleura, the pulmonary pleura, and even the lung-tissue itself, are

liable to be penetrated by the sharp fragments of bone. In some cases the pericardium, or even the heart itself, the liver, the spleen, or the kidneys are also involved in the injury. Bloody sputum, for instance, in cases of direct fracture, is indicative of injury to the pulmonary tissue.

Indirect fractures are due to the action of a force that causes the ribs to bend to a degree exceeding their flexibility. These fractures are found in individuals who have been crushed between car-buffers, run over, etc. The ribs may give way at their angle or at their weakest points: namely, near their sternal or vertebral attachment. Indirect fractures of the ribs are often seen in connection with fracture or contusion of the arm consequent upon a fall, the arm having been violently forced against the thorax, or accompanying contusion of the clavicle (in the case of the first rib) or scapula. The ribs are often broken in connection with fracture of the vertebræ—indirectly in cases involving the bodies of the latter directly, as a rule, when the transverse processes are concerned. In indirect fractures the bony fragments are forced outward. This form of lesion is, therefore, fraught with less danger to the lungs than the other—the direct form.

Muscular action alone may suffice to cause fracture of the ribs. A number of cases are recorded in which the fracture was due to coughing or sneezing; F. Baehr has collected twenty-four such cases out of a total of thirty-five cases caused by muscular action. In most instances such accidents undoubtedly occur in old persons, or as a result of pathologic processes in the ribs. Baehr, however, cites cases of fracture caused by muscular action that can not be thus explained. It is possible, of course, for fracture to occur in healthy persons in consequence of antagonistic action on the part of the abdominal muscles during the lifting of heavy weights. My own observations include several instances of this nature.

One case concerned a workman, sixty years of age, who, immediately after trying to catch a paving-stone that was thrown to him, felt

PLATE 11.

Case of Direct Fracture of the Eighth, Ninth, and Tenth Right Ribs near the Vertebral Column, and of Indirect Fracture of the Seventh and Eighth Ribs, or of Their Cartilages, in the Mammillary Line, Complicated by Fracture of the Body of the Ninth or Tenth Vertebra. Sequel, recovery, with subsequent severe functional disturbances and intercostal neuralgia (referred to under Fracture of the Vertebrae).

A mason, thirty-five years of age, on October 5, 1895, fell from a wall about twenty feet high, sustaining the injuries cited above. I examined him December 28, 1895, and, in addition to the symptoms due to the spinal lesion, the following were noted: The seventh rib on the right side protruded sharply in the mammillary line; over the lower part of the left lung up to about the nipple there were dullness and diminished respiratory sounds; even light percussion was very painful; the least touch over the region between the eighth, ninth, and tenth ribs caused the patient to start back violently. Posteriorly along the spine there was sensitiveness to pressure from the eighth to the tenth ribs inclusive. This sensitiveness could be followed in the intercostal spaces to the front of the chest (intercostal neuralgia). The mobility of the right arm at the shoulder-joint was restricted. Insurance allowance, 100%.

a violent stabbing pain in the left side of his chest. A diagnosis was made of fracture of the left fifth rib near the anterior axillary line.

Healing is, as a rule, marked by only a slight growth of callus, although in some cases a relatively large formation can be observed. I have seen callus-tumors of the size of a walnut, or even considerably larger when situated near the cartilage.

In an average case of fracture of the ribs in a full-grown man union by callus takes place within three or four weeks; the process may, however, be completed earlier, or it may require a much longer time.

The ribs usually remain in position after fracture, but may be considerably displaced. Sometimes we find two adjacent ribs connected by a bridge of callus. When fracture occurs in the neighborhood of the spine, the posterior vertebral fragment is apt to be displaced behind the anterior. In fractures involving the sternal ends of the ribs the reverse holds good. Vertical displacement of





the fragments is also seen in some cases. The injuries of the soft parts—such as the periosteum, pleura, and muscles—are followed by cicatricial growth leading to adhesions and to subsequent contraction of the tissues involved. Aneurysms occasionally develop as a result of laceration of the intercostal arteries, while lacerations or other injury of the intercostal nerves, although causing a great deal of pain at first, may heal perfectly and without sequels. The result is not always so favorable, however, the disturbances sometimes persisting for a long time, or even permanently.

Symptoms of healed fractures of the ribs depend on the form of the lesion (whether direct or indirect), the structure of the ribs, the age of the individual, the manner and duration of healing, and the location of the injury. Certain symptoms, however, are common to all cases.

General Symptoms.—In all cases in which the fracture involves a number of adjacent ribs, symptoms that continue to incommode the patient for a long time are met with on deep inspiration and on movement of the trunk. He finds stooping difficult, as also the lifting of weights, especially with the arm of the injured side. Pain is caused by flexion toward the opposite side and by deep inspiration. The mobility of the thorax is even more seriously affected if bony union takes place between two or more adjacent ribs; in these cases the patient is unable to raise his arm easily or to place it behind his back.

The prognosis as to function largely depends on whether the fracture is due to direct or to indirect violence. In the former case the outlook is usually less favorable, because of the danger of penetration of the periosteum, pleura, and lungs, or other organs, by the sharp fragments of bone.

Local Symptoms.—Fractures in the neighborhood of the spine affect the action of the costotransverse and costo-vertebral articulations, thereby limiting the mobility of the spine and causing pain on movement. Lacerations

of the capsule and of the ligaments of these joints usually accompany the injury. The interarticular ligament, thin and delicate as it is, which binds the head of the rib to the intervertebral discs of two adjacent vertebræ, is doubtless very frequently ruptured in these cases, and the pain felt in the back is probably due in part to this cause. Lesions of the sympathetic nerve, with their attendant train of symptoms, are regularly observed when the fractured bones are forced inward, as occurs in cases of direct fracture due to falls on the back, blows from falling objects, etc., or when the rib is fractured in connection with a similar injury of the body of the corresponding vertebra.

The clavicle is likely to be loosened from its attachment to the first rib, in cases of fracture of the latter, in consequence of laceration of the subclavius muscle or of the costoclavicular ligament. The same injury leads to compression of the subclavian artery, and thereby to disturbances of circulation and nutrition of the arm that it supplies. The mammary artery is likewise exposed to injury from fracture of the costal cartilages.

Direct fractures of certain ribs are likely to injure special organs and structures. Thus, in fracture of the sixth rib anteriorly on either side the pleural sinus is endangered; fracture of the sternal end of the fourth, fifth, and sixth ribs on the left side imperils the pericardium and branches of the pneumogastric nerve; in fracture of the seventh, eighth, and ninth ribs on the right side, the liver; and, in case of the ninth, possibly also the gall-bladder. In fractures of the ninth to the eleventh ribs inclusive, on the left side, and of the twelfth on either side, the spleen and kidneys, respectively, are liable to involvement. The stomach may be injured by forcible compression of the seventh, eighth, and ninth ribs, and the intestine may suffer when the tenth rib is pressed inward or fractured by direct violence.

The following descriptive cases illustrate the fact that

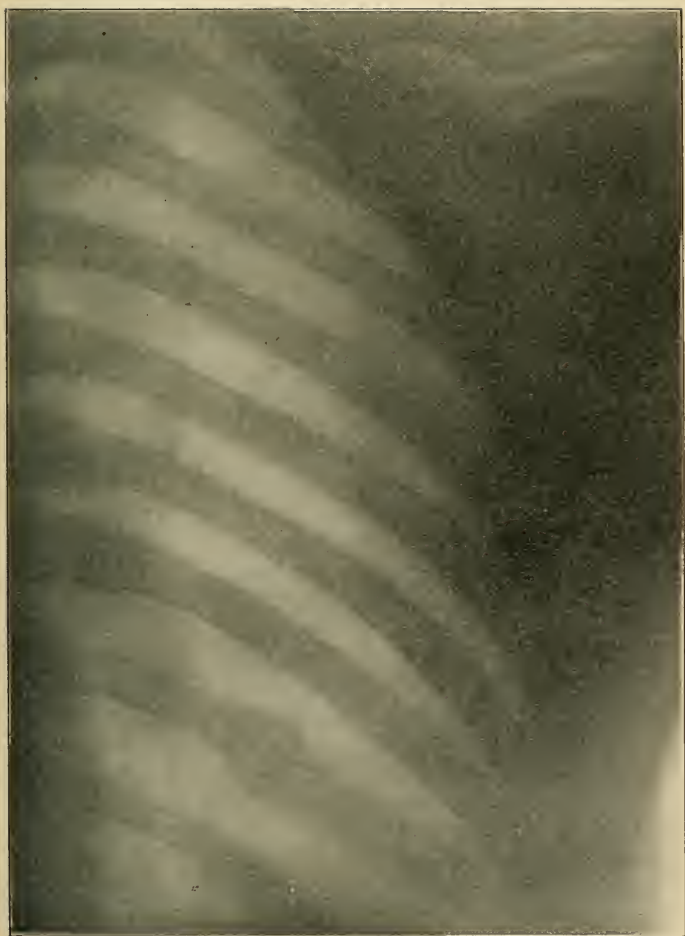


Fig. 26.

the symptoms of healed fractures of the ribs depend largely on the seat of the lesion ; it will, therefore, be unnecessary to state the various local symptoms in detail.

It is important to note that fractures of the ribs can easily be overlooked. This is partly due to the fact that some individuals are rather insensitive to pain, and do not call attention to the lesion by their complaints ; partly to the simultaneous occurrence of other and more serious injuries, which overshadow the one in question.

Case of fracture of the eighth, ninth, and tenth ribs on the right side, followed by intercostal neuralgia and restriction of mobility of the right shoulder. (Fig. 26.)

A workman, forty-four years of age, on June 13, 1898, fell and struck the right side of his chest against the edge of a wall. The injury left a slight callous thickening of the eighth and ninth ribs in the scapular line. There was considerable sensitiveness to pressure in the eighth intercostal space on the right side, and the patient was unable to lift his arm well. The skiagraph shows the point of fracture of the eighth rib, between the scapula and the spine. The patient was dismissed from treatment on October 26, 1898, with an allowance of 20% insurance.

Case of direct fracture of the ninth rib on the right side, followed by a diaphragmatic hernia.

A workman, fifty-seven years of age, on July 5, 1895, fell, striking the right side of his chest against a box of lime. He is said to have remained unconscious for three days in the hospital.

I examined him on September 25, 1895. In the neighborhood of the ninth rib on the right side, and attached to it in the axillary line, there was a marked callous thickening ; dullness, pleuritic friction-sounds, pleuritic cough, and dyspnea were also noted. Beneath the ensiform cartilage there was a tumor about the size of a pigeon's egg, which protruded on coughing and could be pushed back into the abdominal cavity. The patient was unable to raise the right arm well or to do any lifting. Insurance allowance, 66 $\frac{2}{3}$ %.

Case of fracture of the ribs on the right side complicated by injury of the liver. Sequel, partial recovery.

A polisher by trade, fifty-seven years of age, on October 29, 1895, fell from a scaffolding about ten feet high, striking on his back, while the boards of the scaffolding fell upon his right side. He was treated at home for eleven days and then undertook light duties as an inspector.

I examined him February 26, 1896, and found a slight amount of callus on the seventh right rib in the anterior axillary line ; also pleuritic friction-sounds, pleuritic cough, and marked hypertrophy and tenderness of the liver. It was difficult for the patient to raise the right arm on account of pain in the shoulder of that side. He has

not worked since the last of June of that year. I last examined him on August 15, 1896. The liver was further increased in size and was very sensitive to pressure.

Case of fracture of a number of ribs due to severe crushing, complicated by an unusual form of fracture of the clavicle.

A painter, fifty-four years of age, was crushed between a wall and a heavy truck, sustaining a fracture of the right clavicle at its acromial end and a crushing of the thorax. He was treated in the hospital for fourteen days and then began a course of massage. The fracture of the ribs was not diagnosed.

I examined the patient on June 18, 1896, and he remained under my care until April of the following year. Skiagraphs showed a fracture of the fifth, sixth, seventh, eighth, and ninth ribs close to the spine, in addition to the fracture of the clavicle. The pain that he had felt in the spine, especially on stooping, was hereby explained. He did not suffer from pain in the chest after December, 1896.

FRACTURE OF THE COSTAL CARTILAGES.

This lesion may be due to either direct or indirect violence. In old age, when the cartilages have, as a rule, undergone ossification, it is, of course, incorrect to speak of a fracture of the costal cartilages.

Fracture of the cartilages, or of the ribs in their immediate neighborhood, is not infrequently followed by an excessive growth of callus—in reality, an exostosis. The symptoms of the lesion do not differ from those mentioned in connection with fracture of the ribs.

The treatment of healed fractures of the ribs is symptomatic. Mechanical treatment is to be recommended for limited thoracic mobility, while massage and electricity of various kinds may also be employed with advantage.

DISLOCATION OF THE RIBS.

Dislocations involving the costovertebral and the chondrosternal articulations, and those involving the two lowest ribs, are usually considered separately. Dislocations at the costotransverse articulations are properly included with the costovertebral variety, since we are justified in assuming that either one of these lesions leads to the other.

Dislocations of the ribs at their spinal attachment are usually met with as accompaniments of fractures of the vertebrae, and can usually be recognized in severe cases by local pain, especially marked on attempting to move the trunk, by symptoms of intercostal neuritis, and by disturbances due to lesions of the sympathetic nerve. The symptoms in the lighter cases are only slightly marked, and the pain in the spine may disappear altogether in the course of a few months, even in cases of dislocation-fractures involving several ribs.

Dislocations at the chondrosternal articulations are not infrequently seen in workmen who labor in a stooping position or in those who have occasion to lift heavy weights. Frequently, the lesion is really a subluxation, which can easily be reduced by appropriate movements of retroflexion. Dislocation of the first rib also calls for special mention. The lesion, which, by reason of the peculiar conformation and location of this rib, belongs to the class of dislocations by rotation, occurs at the chondrosternal articulation, and is caused by fracture of the rib or by violent contusion of the clavicle. The external border of the rib is forced downward, causing both ends to rotate inward and upward. The remote symptoms of the injury consist of pain in both sternal and vertebral articulations, especially in the latter, pain in the neck, and limited mobility of the head and neck.

THE SEQUELS OF FRACTURE OF THE RIBS.

1. *Intercostal Neuralgia.*

The consequences of the lesion in question have in large part already been referred to in connection with its symptomatology; we will confine ourselves here to mentioning a few of the after-diseases most frequently observed. Intercostal neuralgia is very often induced by direct irritation from displaced fragments, or by pressure from a growing callus or from adhesions following lesions of the pleura.

The characteristic symptoms are pain and extreme sensitiveness in the course of the affected nerve. Sensitiveness can be elicited by pressure, not only at the three points usually tested for diagnosis, but also at any part of the course of the nerve, especially at the points at which it is subjected to the greatest irritation. Other symptoms are limited ability to raise the arm on the affected side, and in many cases exaggerated abdominal reflexes, increased irritability to the faradic or franklinic current, and dilatation of the pupil on the affected side.

Traumatic intercostal neuralgia may soon disappear or may persist for a long time, according to the circumstances of the case; and upon this point depends, to a large extent, the capacity of the patient for self-support. The average incapacity equals 20 %, but rises in some cases as high as 50 % or more, in proportion to the severity of the symptoms.

Treatment consists of warm, moist compresses, massage along the course of the nerve, systematic breathing-exercises, and movements of the trunk, the application of the galvanic current, gradually increasing its intensity, and the use of the static machine.

2. Traumatic Pleurisy.

Traumatic pleurisy is usually of the fibrous variety, and may develop in consequence of direct penetration of the pleura by fragments of bone, or as a result of incomplete fractures of the ribs, of greater or less extent, due to crushing of the thorax between car-buffers, under wheels, under falling walls, etc. Pleurisy has even been known to follow blows on the chest. The symptoms are dullness, pleuritic friction-sounds, and the cough characteristic of pleuritic irritation, always present in severe cases. In addition, there is pain on deep inspiration, on lying on the affected side, on stooping, and on lifting the arm or weights. The expansion of the affected side of the chest is diminished. For the early treatment of these cases warm, moist

PLATE 12.

Case of Contusion of the Left Side of the Thorax due to a Fall into a Cellar.

Sequels, thickened plenra and tuberenosis, resulting in complete incapacity for self-support.

A mason, fifty-three years of age, fell into a cellar on November 28, 1895, sustaining a fracture of the os calcis of both feet and a contusion on the left side of the chest. He was treated in the hospital for eight weeks, during seven of which he remained in bed. I examined him on February 14, 1896, and found him to be a man of middle size, of very delicate physique, and of tubercular diathesis. There was a marked depression of the left side of the chest from the fifth rib downward. (See illustration.) The depressed area was very sensitive on percussion. Circumscribed dullness, diminished respiratory sounds, pleuritic friction-sounds, and diminished expansion of the left side of the chest were also noted. On stooping, the lower border of the left ribs became very prominent. Lateral movements of the thorax were limited, especially movement toward the right. The patient was discharged after four months' treatment with an allowance of 100%, based on his pulmonary tuberenosis.

compresses, rest (in bed, if necessary), and small doses of morphin are to be recommended.

Less severe cases may manifest few or no symptoms. Patients frequently resume hard work after a course of treatment of from ten to twelve days' duration. In a stone-carrier, for instance, whom I had occasion to examine, and who, as usual, was engaged in hard labor, I found extreme dullness and pleuritic friction-sounds. The capacity for self-support varies, it is thus seen, with the personal equation of the patient.

The presence of pleuritic symptoms in an otherwise perfectly healthy individual should entitle him to an insurance allowance of 20%; severe symptoms may call for a higher allowance, even 100%.

The pleurisy may clear up comparatively soon or may persist for a long time or even permanently; not infrequently it is the starting-point for the future development of tuberculosis.

The pleuritic inflammation occasionally takes a serous or suppurative form, requiring a prolonged course of treat-





ment. One workman, who developed an empyema after fracture of a rib, was under treatment for three years before the fistula finally closed and the fever disappeared.

Contusions of the thoracic wall and healed fractures of the ribs are not infrequently made use of for purposes of simulation. On hasty examination a constant cough induced in the larynx or pharynx may be mistaken for the cough of pleurisy, and an incorrect diagnosis of traumatic pleurisy may be made accordingly.

Case of empyema on the left side following crushing of the left thigh, with subsequent cellulitis and contusion of the left side of the thorax, complicated by concussion of the brain. Sequels, thickened pleura and a deep cicatrix at the site of the fistula. Four years later, complete recovery of capacity for self-support.

A workman, thirty-two years of age, fell from a scaffolding two stories high on December 29, 1893, sustaining the injuries mentioned. There were no thoracic symptoms at first. Four weeks later, after the appearance of a cellulitis of the left thigh, pleurisy set in, with chills and high fever. Improvement followed incision and drainage.

I examined the patient on April 17, 1894, and found a fistula, still discharging pus, between the seventh and eighth ribs on the left side. There was dullness over the whole left side of the chest. The general health was good as long as drainage remained free; symptoms of fever and chills were manifested whenever the fistula closed, but were always relieved by reopening the same. The treatment was continued until January, 1897, when the patient was discharged with an insurance allowance of 75%. He began to work, and was finally able to perform his duties so well that his allowance was diminished to 10%.

3. Injuries and Traumatic Diseases of the Lungs.—Hemoptysis, Pneumonia, and Pulmonary Emphysema.

The lung-tissue is lacerated in case of direct fracture of the ribs; also in case of violent contusions of the thorax due to falls from a height and to similar accidents. The immediate symptoms are cough and bloody sputum, and these may be followed by those of inflammation of the lungs.

Pneumonia is observed also after less severe contusions of the thorax (contusion-pneumonia); the course of the disease is marked by only a slight rise of temperature, so that the patient frequently attempts to resume work, but

is soon obliged to discontinue it again. In passing we need refer only to the pneumonia induced by catching cold, which in some cases also entitles the patient to insurance allowance.

Pulmonary emphysema is frequently of traumatic origin, usually developing as a sequel to long-continued pleuritic cough, especially in individuals suffering from chronic bronchitis.

Hemoptysis sometimes occurs in consequence of strains—lifting a heavy stone, for instance. This symptom depends on laceration of the lung-tissue and its capillaries, and in healthy individuals may cause no further trouble. Pulmonary tuberculosis is, however, very apt to supervene in those who, by reason of their occupation, have a predisposition to the disease.

Case of pneumonia and pleurisy consecutive upon falling into cold water. Sequel, myocarditis, myelitis, and neurasthenia; subsequent improvement.

A workman, fifty-nine years of age, a heavy drinker, fell into the water on January 18, 1894. He was treated in the hospital for a long time, and was then discharged improved, only to be readmitted on account of myocarditis, of which the symptoms had meanwhile increased. The following symptoms were noted, in addition: loss of pupillary reflex, ataxic gait, swaying of body on closing the eyes, and exaggeration of the patellar reflexes. Incapacity for self-support, 100%; later, when the symptoms diminished, 50%.

A case of hemoptysis due to rupture of the lungs from lifting a heavy stone. Sequel, pulmonary tuberculosis, causing death in two years.

A stone-mason, forty-eight years of age, probably already tubercular, fell in attempting to lift a heavy stone, on August 22, 1889. The accident was immediately followed by hemoptysis.

I examined him three months later and found a cavity in the right lung below the clavicle; also a few râles at the left apex. Insurance, which was at first denied on the ground that the accident was not one covered by the rules of his trades-union, was afterward allowed him at the rate of 100%. He died two years later of pulmonary tuberculosis.

Case of hemoptysis following the lifting of a heavy beam. Sequel, complete recovery.

A workman, thirty-seven years of age, in lifting a heavy beam, on July 10, 1894, felt a sudden violent pain and jar in the right side of the chest. Hemoptysis followed. He was treated at home for eight weeks. I examined him three months after the injury and found a fibrous pleurisy of moderate intensity on the right side. As

he was able to do full work, he was not considered to be entitled to insurance.

Case of hemoptysis due to laceration of lung-tissue in connection with fracture of the ribs following a fall from a height of sixty feet. Sequel, emphysema of the lungs.

A mason, thirty-five years of age, fell from a scaffolding sixty feet high, on November 16, 1888, sustaining a fracture of the skull, laceration of the lung, and a fracture of the right arm; also a fracture of the ribs on the right side, which was not diagnosed until later. He was treated in the hospital for thirteen weeks and then entered my care, in which he remained for one year. Symptoms, loud râles over the whole of the right lung, bloody sputum, and marked loss of flesh. The symptoms gradually decreased in the course of time. At present he is still suffering from emphysema. He was allowed 100%, based on headache, attacks of vertigo, and limited mobility at the right shoulder.

Case of hemoptysis following a trifling injury. The influence of the accident was recognized.

A workman, thirty-five years of age, already tubercular, on January 8, 1896, stepped from the sidewalk into the street in order to decipher the number of a house. He states that this action was immediately followed by pain in the back. Ten days later he had a hemorrhage from the lung, and was treated in the hospital for a week. He had previously suffered from attacks of hemoptysis. Insurance was denied him by his trades-union because of the tuberculosis; he was declared to be entitled to it, however, by the court whose opinion was based on the detailed and unprejudiced certificate of the physician who examined him.

4. Traumatic Tuberculosis of the Lung.

It is undoubtedly in rare cases only that tuberculosis develops as a direct result of traumatism. As a rule, tuberculous foci are already present and are called into activity by the injury, or the development of the disease is only hastened by the latter. The exciting traumatism does not necessarily involve the region of the tuberculous focus; the injured part may recover rapidly and completely, while the tubercular process is aroused at a distant spot.

The tuberculosis may be latent or in the early stages of its development, giving rise to scarcely any symptoms, until active symptoms are induced by traumatism or by long confinement in an unwholesome dwelling infected with tubercle bacilli.

Pulmonary tuberculosis may, however, develop in close connection with traumatism as a sequel to a traumatic hemorrhage, which furnishes a suitable soil for the growth of the invading bacilli.

The tubercular process may manifest itself as a primary local lesion after injury to the lung or pleura, or it may be established in some part of the lung as a result of metastasis from a tuberculous focus developed after traumatism in some other part of the body. Pulmonary tuberculosis usually incapacitates the patient for work to a very considerable degree; he is always unable to perform hard labor, and in many cases can not undertake even the lightest tasks.

INJURIES AND TRAUMATIC DISEASES OF THE HEART AND PERICARDIUM.

1. Traumatic Pericarditis.

Direct lesions of the pericardium are usually due to its penetration by fractured ribs, but may be caused by pressure from ribs forced inward by sudden violence. Düms reports cases of traumatic pericarditis in soldiers who had been injured by blows from bayonets, by kicks, or by falling and striking the left side of the chest against the horns of their saddles or by being thrown to the ground from horseback. Thiem has published a fatal case of traumatic pericarditis and pleurisy due to severe crushing contusion. If the pericardium is already diseased, it is, of course, much more liable to inflammation as a result of traumatism than is normal tissue.

The pericardium is in some cases involved secondarily by extension from a traumatic pleurisy.

The symptoms of traumatic pericarditis may be severe from the onset or may at first be so slightly marked as to be overlooked until they suddenly break out later on. Two cases are related by Düms, both occurring in soldiers who had been in service until shortly before their deaths.

The autopsy showed the two layers of the pericardium to be adherent almost throughout.

Alcoholic or tuberculous subjects are predisposed to pericarditis. The loud crackling friction-sounds, not necessarily associated with the movements of the heart, that characterize the lesion can be heard also in the late stages of the disease. Frequently adhesions take place between the pericardium and the heart-muscle, causing disturbances of cardiac action and atrophy of the muscle. As long as the symptoms persist the patient is almost completely incapacitated for work, and should be prohibited from all exertion or, at any rate, from all but the very lightest tasks.

Case of pericarditis following fracture of the left sixth rib, caused by a fall from a height.

A workman, thirty years of age, fell, on December 20, 1893, from a height of sixteen feet, sustaining a fracture of the sixth rib in the left mammillary line. He was treated for four weeks with ice-bags in the hospital. After his discharge he became a patient at the dispensary, where the following symptoms of pericarditis were demonstrated: Dyspnea; a very small, rapid, and irregular pulse; friction-sounds and increased area of heart-dullness. These symptoms disappeared at the end of three months. He was allowed 50% insurance on the ground of *neurasthenia*.

2. Injuries of the Heart Due to Concussion.

Direct cardiac lesions have been reported as occurring in individuals thrown from a moving train (case of Liersch), or in those who have fallen from the upper story of a house, striking on the buttocks (case of Riedinger). In the case described by Liersch autopsy showed hemorrhages under the endocardium.

Lacerations of the heart-muscle, also of the papillary muscles, valves, and chordæ tendinæ, have been found in cases of crushing of the thorax between car-buffers, under falling walls, etc., or as a result of kicks from animals (Stern and Bernstein).

The cardiac muscle or the valves may also be lacerated in direct consequence of strains—due to the lifting of

heavy weights, for instance. A case published by Schindler was that of a very strong hod-carrier, who was accustomed to carrying a load of forty-two bricks, weighing 165 kilos, on his shoulder, while his fellow-workmen were able to carry only thirty-two, weighing 120 kilos. In attempting to carry forty-eight bricks he broke down, and became ill. One year later, when fully recovered, he again attempted the same extra load, with the same result. A diagnosis was made of acute dilatation of the left ventricle, with mitral insufficiency and irregular heart-action, leading to edema and ascites, completely disabling the patient.

According to Bernstein, the laceration is most likely to occur in that part of the cardiac structure that is in a state of tension at the moment of injury. Thus, during systole the cardiac muscle suffers; during the second half of diastole, when the muscle is relaxed, the endocardium; and during the whole diastole of the ventricles, the valves that lie in front of them. Bernstein states that the valvular lesion of traumatism is characterized by a rough murmur, audible at a considerable distance, differing from the murmur of gradual development heard in cases of valvular insufficiency of inflammatory origin. A murmur audible at a distance of over fifty centimeters may, he says, be assumed to have a traumatic cause. Lesions of this nature have been observed involving the mitral, tricuspid, and semilunar valves.

The symptoms of traumatic cardiac lesions are, in the main, those of similar lesions of nontraumatic nature; the patient is usually greatly incapacitated for work, being able to perform only light tasks requiring no physical exertion, if, indeed, he is able to work at all.

3. Influence of Traumatism on Preexisting Heart Disease.

Hearts that are already the seat of some morbid process are necessarily much more likely to suffer from the effects of traumatism than are previously healthy organs.

Stern gives the following causes for the increase of cardiac symptoms after accidents :

1. Mental excitement.
2. General concussion and direct injuries, such as contusions, crushings, etc.
3. Muscular exertion or strain.

Thiem adds a fourth cause : namely, sudden cooling of the body.

Cases of all these forms of injury can be found in abundance in the literature.

4. Aneurysm of the Thoracic Aorta.

A case of this lesion is published by Pauli in which the patient, a coachman, fifty-three years of age, was struck on the left side of the chest by a moving railroad-car. He suffered at first from extreme dyspnea ; then, after a short period of slight improvement, he again became ill, this time with severe symptoms of palpitation of the heart as well as dyspnea. The area of heart-dullness extended to the right margin of the sternum, while the whole region pulsated strongly. The heart-sounds remained normal. The accident occurred on March 3, 1894 ; in October of the same year it was noticed that the second and third left ribs were beginning to protrude. The patient died suddenly on August 28, 1895. Autopsy showed an aneurysm about ten centimeters long ; the heart was greatly hypertrophied, especially the left ventricle ; the first part of the aorta was much dilated, preventing closure of the semilunar valve.

Case of mitral insufficiency following severe crushing of the left side of the chest. Sequel, partial recovery.

A mason, thirty-two years of age, on September 16, 1892, was caught under a falling building. He sustained the foregoing injury, and, in addition, a severe contusion of the right hip. He was treated at home for three months, with compresses and rest in bed, and then came under my care. He showed symptoms of sciatica on the right side, and complained, in addition, of frequent attacks of dyspnea. Examination was negative, except that there was a rapid pulse. The heart-symptoms increased a few weeks later, and were accompanied by

fever. He was again ordered to remain in bed. The physician in attendance at his home made a diagnosis of endocarditis. When I examined him subsequently, I found the apex-beat displaced to the left, a blowing systolic murmur, and the area of heart-dullness enlarged toward both sides. Insurance allowance, 50%. No change in his condition up to date.

IV. INJURIES AND TRAUMATIC DISEASES OF THE ABDOMEN.

Although the abdominal organs are not protected from external violence by a bony framework, as are the brain, the spinal cord, and the thoracic organs, they are nevertheless well adapted to evade the effects of traumatism. This is especially true of the stomach and intestines; less so of the glandular organs—the liver, kidneys, and spleen; the latter, however, by reason of their position in the body, are less exposed to external injury. The ability of the stomach and intestine to escape injury by moving to one side has, of course, its limits, and when filled with gas or food-contents, they are not easily displaced, and are, therefore, in much greater danger from traumatism.

The lesions of the internal organs do not always correspond in situation to the point to which the external violence is applied; if kicked by a horse, for instance, on the lower left part of the thoracic wall, the individual may suffer comparatively little damage at that point, while the intestine is ruptured at a distance.

I. INJURIES OF THE ABDOMINAL WALL.

(a) Wounds and Cicatrices of the Abdominal Wall.

Superficial wounds in this situation, including those caused by burns, usually heal well, and without sequels of importance. Extensive scars, however, especially if showing a tendency to keloid formation, are likely to give rise to a feeling of tension and pressure. The symp-

toms of scars left by deep wounds are more marked and vary in intensity in proportion to the depth of the scar-tissue and to the adhesions it forms. The broad scars that sometimes follow perforating abdominal wounds lead to the development of omental hernia, and, finally, to hernia of the intestines.

(b) Subcutaneous Rupture of Abdominal Muscles.

This lesion occurs in consequence of violent contraction when the muscle is in a state of extreme tension, as in lifting and carrying heavy weights with the hands, the trunk being inclined backward. Subcutaneous ruptures are also met with when the body is in a position of extension, as, for instance, in hanging from horizontal bars. The rectus is most subject to the injury, the external oblique somewhat less so. I have seen a rupture of the external oblique in a recruit undergoing fatiguing practice on horizontal bars, and a rupture of the same muscle in a woman about forty-five years of age as a result of strain in lifting. The muscles heal in from three to six weeks, usually leaving a depression or groove at the point of rupture. Hard labor, lifting, and carrying heavy loads are, of course, out of the question at first; but as strength gradually returns, even such work can once more be undertaken. Incapacity for self-support, 20 % to 33 $\frac{1}{3}$ %.

2. INJURIES AND TRAUMATIC DISEASES OF THE STOMACH.

(a) Contusions and Crushing of the Stomach.

When empty, the stomach usually escapes the effects of a blow or kick by moving aside; but it may suffer serious lesions, as a result of compression against the vertebral column, in cases of crushing between car-buffers, under falling walls, wheels of wagons, etc. The lesion may consist of lacerations of the mucous membrane,

of hemorrhage between different layers of the stomach-wall, or even of rupture of the latter, demanding immediate operation. When the organ is full, the mucous membrane is sometimes torn as the result of comparatively slight injuries, such as simple contusions or muscular strain in lifting, or concussion due to falls from a height. As a rule, the stomach, in these cases, is already the seat of some morbid process. Rupture of the gastric mucous membrane is immediately followed by hematemesis or bloody passages from the bowels. In cases of gastric ulcer due to infection of the injured mucous membrane through the stomach-contents hematemesis may occur as a somewhat later symptom.

Case of contusion of the chest and stomach due to a blow from a wagon-pole. Sequels, chronic gastritis, thickened pleura, and pulmonary emphysema.

A workman, sixty-four years of age, on October 13, 1892, was struck on the lower anterior border of the ribs on the left side by a wagon-pole. He at once became unconscious, and was carried home, where he was treated for traumatic pleurisy.

I examined him on January 20, 1893, and found him to be a small, delicate man, who, however, stated that he never was seriously ill before his accident, having suffered only from paralysis of the vocal cords. The patient complained of attacks of nausea, poor appetite, and a feeling of pressure in the stomach; his tongue was coated. Further examination showed a thickening of the left pleura and some emphysema of the lungs; also tenderness on pressure in the region of the stomach. Insurance allowance, 75%.

(b) Traumatic Ulcer of the Stomach.

These ulcers usually heal rapidly, but in some cases lead to perforation. It is hardly necessary to state that perforation may take place at the site of a nontraumatic ulcer in cases of traumatism, thereby entitling the patient to receive insurance. The cicatrix left after healing is completed causes no after-trouble in favorable cases, but occasionally proves to be the starting-point of a carcinomatous growth.

Weak, anemic individuals, particularly alcoholics, are predisposed to gastric ulcer.

The patient should be ordered rest, possibly in bed. The insurance allowance may equal 100 %.

(c) **Carcinoma of the Stomach.**

Reference has just been made to the origin of carcinomata at the site of gastric ulcers. Carcinoma seldom occurs in consequence of a single traumatic insult, but is usually the outcome of constant irritation of the scar-tissue. If the mucous membrane is already unhealthy, however, it is also possible for a carcinoma to develop after a single injury. The underlying cause may, for instance, be a chronic gastritis; the immediate cause, a traumatism that produces a laceration of the mucous membrane, leading successively to a gastric ulcer, a cicatrix, and finally to the development of a carcinoma. The cases of traumatic carcinoma that have come under my observation occurred in individuals between forty-five and fifty-five years of age, all of whom suffered from chronic gastritis due to alcoholism.

The etiologic connection between traumatism and carcinoma must be clearly proved on scientific grounds; it will not do, for instance, to try to connect an inflammation of the elbow-joint or a wound of the head with a primary carcinoma of the digestive tract of subsequent development. In respect to this point, see also the opinions of Schönborn, Senator, and Renvers, published in the official reports of the State Insurance Bureau.

Case of carcinoma of the stomach the development of which was hastened by an accident. Fatal termination.

A carpenter, fifty years of age, fell from a height of about two stories on July 9, 1898, sustaining a fracture of the right scapula complicated by concussion of the brain. He was treated for a month or more in the hospital. I examined him on November 2, 1898, and found him to be a rather large, thin man of sickly appearance. The spine of the right scapula was distinctly thickened, and the right arm could not be raised above a level with the shoulder. He was treated clinically by means of exercises of the right shoulder. On December 29, 1898, he did not appear at the clinic, and was, therefore, visited at his home. He was found to be suffering from gastric disturbances, but had no fever. He stated that he had noticed a loss of appetite

and rapid loss of strength ever since his accident, and that he was previously quite healthy. He confessed to having drunk a moderate amount of whisky daily and to having eaten irregularly. Hematemesis occurred on January 18, 1899, when he was taken to the hospital on account of a tumor of the stomach. He died there soon afterward. Autopsy showed a carcinoma of the stomach. The traumatic etiology was admitted.

(d) **Nervous Dyspepsia.**

Reference is here made to this affection for the reason that we often meet with it as a symptom of accident-neurosis, and that it very frequently calls for treatment. In addition to other treatment, psychic methods are to be recommended.

3. INJURIES AND TRAUMATIC DISEASES OF THE INTESTINE AND THE PERITONEUM.

(a) **Contusions and Crushing of the Intestine.**

The intestine, like the stomach, is likely to escape injury from external violence, such as falls, blows, or kicks, when it is empty. If, however, it is the seat of typhoid ulcers (in cases of walking typhoid) or of tubercular ulcers, rupture of the mucous membrane, or even perforation of the intestinal wall, may easily occur. The intestine may be ruptured in healthy persons by crushing of the abdomen, due to being run over, caught under falling buildings, etc. This lesion is more likely to occur when the intestines are filled. The most frequent traumatic causes of intestinal rupture are kicks and violent concussion consequent upon falls from a height. Rupture may occur at the time, or gangrene may set in at the point of injury, leading to perforation several days later. In other cases the lesion in the mucous membrane is in the process of healing, when peristalsis or some movement on the part of the patient causes the weak spot to give way, and a perforation results.

If the accident does not cause immediate death, the patient's life may be saved by operative interference. An

instance of this kind, including a description of the sequels, will be found among the illustrative cases.

Minute openings in the intestine, several millimeters in length, may heal without difficulty; even if there is an escape of intestinal contents, these openings may become encapsulated and recovery may take place. Internal ruptures are, therefore, not necessarily fatal accidents.

(b) Wounds of the Intestine.

These occur in cases of fracture of the ribs, vertebræ, or pelvis, the sharp fragments piercing the intestine; or they are produced from within by the action of foreign bodies that have been swallowed. The only hope of recovery lies, as a rule, in immediate operation.

(c) Intestinal Stenosis and Occlusion.

Stenosis of the intestine, up to complete occlusion, may occur as a result of traumatism. Among the direct causes are foreign bodies in the intestine, cicatricial strictures, and incarcerated hernias. The first aim of treatment should, of course, be the removal of the cause.

(d) Traumatic Peritonitis.

Lesions of the peritoneum are invariably accompanied by more or less extensive lacerations of the omentum and of the vessels that it contains. The injury and the subsequent hemorrhage are followed by a peritonitis, as a result of which the extravasated blood may become encapsulated, forming a hemothecæ. The peritonitis in itself is rarely of a very serious nature.

Hermes mentions the case of a man who fell on a beam from a height of one story, striking upon the abdomen, thereby causing a complete laceration of the omentum between its middle and lower thirds and almost entirely separating the small intestine from its mesentery. Thiem describes an interesting case of incarceration of a coil of

small intestine in a tear in the mesentery, occurring in a man who had leaped across a ditch with the aid of a pole.

The peritonitis may assume a suppurative character in consequence of the passage of infectious bacteria either through the uninjured intestinal wall or out of the blood-vessels in which they may be circulating.

Traumatic peritonitis often leads to the formation of adhesions with neighboring organs; these are likely later on to give rise to rather severe, ill-defined pains, often ascribed to hysteria or to simulation, or set down as "colic."

Carcinoma of the peritoneum is usually of metastatic origin, the primary focus being seated in the stomach, liver, or rectum, etc.

Case of perityphlitis following severe crushing of the abdomen. Sequel, recovery, with persistence of various symptoms.

A workman, thirty-three years of age, was injured in November, 1887, by a rail falling on the right side of his abdomen. He was treated in the hospital for a number of weeks, and soon after his discharge was readmitted on account of a psoas abscess. I examined him on October 27, 1888. I found him to be a man of middle size and vigorous build and of rather pale complexion. He complained of abdominal pain, of severe constipation, sometimes lasting for eight days or longer, and of a sense of weight in the right leg. At the lower part of the abdomen on the right side was situated a flat tumor, about the size of the palm of the hand, slightly raised above the level of the surrounding tissue. The whole right side of the abdomen was sensitive to pressure and the right lower extremity was swollen, the circumference of the thigh being three centimeters greater than that of the left. He was at first allowed full insurance, which was reduced in six months to 50%, and in two years to 20%. At the time of the last examination, early in the year 1899, the tumor in the right side of the abdomen had disappeared and the swelling of the right thigh had diminished.

(e) Laceration of the Thoracic Duct.

In his "Manual" Thiem cites a case observed by Manley concerning a man thirty-five years of age who was knocked down by a wagon-pole, which struck him in the abdomen, one wheel passing over his body. The injury was followed by severe pain; a tumor developed over Poupart's ligament on the right side, which was tapped eleven days later, yielding a pint of a milky-white fluid.

4. INJURIES AND TRAUMATIC DISEASES OF THE LIVER.

Lesions of this organ may be due to direct or indirect violence. Contusion and crushing of the liver belong to the class of direct injuries, and are met with in individuals who have received blows from butts of guns, horns of animals, or wagon-poles, or who have been struck with the fist or kicked by horses, cattle, etc. They also occur in persons who have fallen on the abdomen, or who have been caught under heavy falling objects, under falling buildings, under wheels, between parts of machinery, car-buffers, etc. Lesions of the liver due to direct violence are not infrequently seen in connection with complete or incomplete fractures of the ribs.

Indirect lesions are caused by falls from a height, striking on the feet, the buttocks, the back, or the left side of the abdomen.

If diseased, the liver may be ruptured by a slight degree of violence, as when it is the seat of a hydatid cyst; the consequences of injury, too, both immediate and remote, are likely to be more serious than in the case of a healthy organ.

The symptoms of injuries of the liver depend on its physiologic condition and on the severity of the lesion; slight hemorrhages or small tears of the surface are followed by very mild symptoms, or cause only moderate pain. Rest and suitable treatment bring about recovery in these cases.

Ruptures of the liver, on the other hand, often terminate fatally very shortly after the accident; the lesion is in many cases marked by characteristic pain in the right shoulder. Patients who survive the injury suffer from jaundice, localized peritonitis, or, less frequently, from abscess of the liver, which, as it is well to remember, may remain latent for years.

In healing, adhesions are formed between the surface of the liver and its peritoneal coat, causing pain, especially on movements requiring considerable exertion, on unusual

degrees of peristalsis, or when the stomach and intestines are full and heavy.

In view of the inability of the patient to perform hard work, he may be entitled to an insurance allowance of from $33\frac{1}{3}\%$ to $66\frac{2}{3}\%$, or more.

Carcinoma of the liver is usually a secondary process, the result of metastasis from a primary growth in the stomach, rectum, esophagus, or intestine; in rare cases we find a primary carcinoma of the bile-duets.

5. INJURIES AND TRAUMATIC DISEASES OF THE SPLEEN.

Direct contusion and crushing of the spleen may occur in connection with crushing and fracture of the ninth to eleventh ribs, leading to hemorrhage and laceration, and to loosening of its ligamentous attachments, and to subsequent inflammation of the organ and its coats. Occasionally, a wandering spleen is observed after traumatism. As a result of inflammation, adhesions take place between the spleen and adjacent organs. Chronic hypertrophy and leukemia have likewise been observed. In cases of malaria or leukemia the spleen is occasionally ruptured by trivial accidents.

6. INJURIES AND TRAUMATIC DISEASES OF THE PANCREAS.

Hemorrhagic and suppurative pancreatitis and necrosis of parts or the whole of the organ have been known to occur as the result of a fall or of being run over. Cysts of traumatic origin have been observed in a number of cases, giving rise to the following symptoms: a grayish-yellow coloration of the skin, similar to that seen in Addison's disease; gastric disturbances, vomiting, and neuralgia.

7. INJURIES AND TRAUMATIC DISEASES OF THE KIDNEY.

The kidneys may be injured by direct or indirect violence. They are most exposed to direct injury from behind, below the eleventh or twelfth rib, but may also be reached anteriorly or from the side. Fracture of the eleventh or twelfth rib may cause a direct lesion of the kidney, while in case of fracture of the eleventh or twelfth dorsal vertebra, or of the first or second lumbar vertebra, the lesion may be either direct or indirect.

Contusion and **crushing** of the kidney occur in consequence of kicks, or blows from sticks, wagon-poles, etc. ; also in individuals who are run over or caught under falling walls, etc. If diseased, the kidney may be indirectly injured by falls on the buttocks or by muscular contraction—the lifting of heavy weights, for instance.

The lesion produced by the various forms of traumatism mentioned usually takes the shape of a laceration, accompanied by more or less severe hemorrhage and followed by hematuria, which is the most striking symptom produced. It may appear at once or may be delayed until the clots that temporarily fill the laceration become detached. In some cases hematuria does not appear ; the blood collects between the layers of the capsule, giving rise to inflammation (traumatic nephritis), or forming a cyst, or leading to the development of a perinephritic abscess, accompanied by the formation of calculi and the atrophy of the kidney. Injuries to the kidney are occasionally followed by anuria, either of reflex origin or due to the fact that the second kidney is diseased or lacking. Albuminuria, causing edema of one or both legs, frequently involving the side opposite to the injured kidney, is another symptom of traumatic nephritis.

Lacerations of the kidney are not necessarily accompanied by severe symptoms ; the latter may be quite trivial, causing no discomfort after the first few days.

Floating kidney is frequently met with, especially in women, and may depend on one of several cases: diminution in the normal amount of adipose tissue surrounding the kidney, relaxation of the abdominal walls, a tumor of the kidney or neighboring structures, or *traumatism*. Thiem agrees with Cruveilhier in explaining the traumatic origin of floating kidney by the narrowing of the niche or groove in which the kidney rests, which takes place as the result of external violence or depends on internal causes. Blows from behind and from the side or falls on the abdomen or against sharp-edged objects have the effect of forcing the lower ribs toward the spine, thereby narrowing the kidney groove. Muscular contraction may act similarly on the ribs, as when, after slipping, a person tries to regain his equilibrium, and in so doing involuntarily contracts certain muscles—the quadratus lumborum, the erector spinæ, and the abdominal muscles. Continuous attacks of coughing also reduce the size of the groove containing the kidney, which explains the appearance of floating kidney subsequent to heavy lifting or to other work requiring severe exertion during which a prolonged attack of coughing occurred. The condition is further favored by lordosis of the spine, which itself may be of traumatic origin.

The symptoms of floating kidney are of a kind usually regarded as hysteric. They consist of anesthesia and hyperesthesia of the mucous membrane of the bladder; pain in the lower part of the back and in the loins; disturbances of digestion, which may be due to pressure of the displaced kidney on the duodenum; and jaundice caused by pressure or tension on the common bile-duct. If the pedicle becomes twisted, there may, in addition, be urinary disturbances, albuminuria and fever, and even hydro-nephrosis.

The symptoms can be relieved by a suitable abdominal bandage or can be cured by surgical interference, with the object of fixing the displaced kidney in position.

Traumatic hydronephrosis, in addition to twisting of the kidney pedicle, may be due to occlusion of the ureter from the following causes :

1. Traumatic stricture.
2. Presence of a coagulum.
3. Impaction of a renal calculus loosened from the kidney by traumatism.
4. Compression from hemorrhagic extravasation or by tumors of the peritoneum or ureter.

Perinephritis sometimes occurs as a sequel to a hemorrhagic extravasation at the point of injury, which subsequently became infected. The abscess either points below the twelfth rib or breaks through the trigonum of Petit, or it descends into the pelvis or inguinal region, to appear as a psoas abscess.

Penetrating wounds of the kidney caused by pointed instruments may run a very favorable course if surgical aid is at once summoned. In one case of my own (mentioned among the illustrative cases) the patient was able to resume regular work about three months after the injury.

The rate of insurance to be allowed for the various injuries of the kidney and their sequels depends on the severity of the symptoms in the later stages of the injury ; these may be so slight as not to interfere in the least with work or they may incapacitate the patient to a large degree.

Carcinoma of the kidney occasionally develops after traumatism. In a case of Löwenthal's cited by Thiem, in which the etiologic relation was fully established, death occurred seventeen years after the accident.

The insurance allowance for the loss of one kidney by operation is from $33\frac{1}{3}\%$ to 50% .

Case of floating kidney following contusion of the back and "laceration of the kidney." Sequel, decided improvement and complete capacity for self-support.

A mason, twenty-seven years of age, on August 30, 1893, fell and struck the right side of his back against a projecting screw of a machine. Hematuria is said to have occurred immediately afterward.

Examination a few weeks later showed a floating kidney on the right side. The symptoms were pain in the back and abdomen, nausea, and absence of kidney-dullness on the right side. On October 11, 1894, the floating kidney had disappeared; the patient was, therefore, declared capable of self-support.

Case of rupture of the kidney due to a fall from a scaffolding. Sequel, hydronephrosis; subsequent improvement.

A carpenter, twenty-six years of age, fell backward from a scaffolding nine feet high on August 28, 1895. He sustained a contusion of the back and a laceration of the left kidney, for which he entered the hospital for treatment.

I examined him on January 28, 1896. He was a small, thick-set, pale-faced man. The region of the left kidney posteriorly was distinctly swollen; the percussion-note was tympanitic and the boundaries of kidney-dullness were extended on all sides. Albumin was present in the urine. The patient was treated in the dispensary and hospital, and evinced improvement later on. Insurance allowance, 30%.

8. INJURIES AND TRAUMATIC DISEASES OF THE BLADDER, URETERS, TESTICLES, AND PENIS.

Lesions of the bladder, including rupture, are met with as the result of direct violence in individuals who have been run over, caught between moving objects, under falling walls, etc., or who have sustained a fracture of the pelvis, the organ having been pierced by the broken bones. Indirectly, the bladder may be injured by lifting heavy weights. It is much more liable to suffer when full than when empty. Immediate operation may save the patient's life and may lead to permanent recovery.

Lesions of the bladder may be followed by catarrhal inflammation, calculus, or polyuria; the last-named affection is especially burdensome to a working-man.

Crushing of the testicle may be followed by hydrocele, hematocele, or suppurative orchitis. If a hydrocele is already present, the injury is likely to cause considerable hemorrhage, which is best treated by operation, although good results may also be obtained by elevation of the thighs, rest in bed, and the application of compresses. A suspensory bandage should subsequently be worn for some time.

Cutaneous wounds of the testicle, if properly treated, heal quickly and completely. Unless inflamed, a hydrocele of moderate size usually causes no trouble whatever, and its presence does not necessarily interfere with hard work. In estimating the insurance we should, therefore, not allow high rates, unless signs of inflammation are found, and if so, we should treat the condition.

The **loss of one testicle** is of no special importance so long as the other is healthy. The loss of both testicles not only destroys the power of procreation, but entails, in addition, a series of nervous symptoms. An allowance of 50% is, therefore, frequently justified.

Tuberculosis has been known to develop in one or both testicles as the result of crushing. For these cases castration is indicated.

It is reasonable to believe that **carcinoma of the testicles** may develop in consequence of traumatism, but each case must be carefully examined with reference to its etiology, since the disease is quite frequently observed when no history of injury is given.



Fig. 27.

The strictures of the urethra that usually form after traumatism are likely to cause difficult micturition, requiring treatment and partly unfitting the patient for work. An insurance allowance

PLATE 13.

Case of Acquired Ventral Hernia Intensified by Traumatism.

A workman, fifty-three years of age, in trying to extricate himself from a mass of earth which had fallen around him, covering him up to his knees, felt intense pain at the umbilicus, at which point there had existed a small hernia for a long time. The hernia is stated to have greatly increased in size after the injury, and at the time of my examination it was about the size of the palm of the hand. The patient had a rather prominent abdomen. He complained of continual pain in the abdomen, and stated that he was unable to walk without an abdominal bandage. He also suffered from periosteitis of the tibiae. The total insurance allowance equaled 50%.

of from 25% to 50% is frequently justified in these cases.

Wounds and contusions of the penis may give rise to scars and deformities, sometimes involving a loss of functional power. Urethral strictures also occur in this connection. The same rate of insurance is allowed for loss of the penis as for the loss of the testicles.

Case of severe contusion of the abdomen and rupture of the bladder, due to the kick of a horse. (Fig. 27.) Followed by operation and recovery.

A driver, twenty-two years of age, was kicked in the abdomen by a horse. He became unconscious and was taken at once to a hospital and there operated upon.

I examined him on March 20, 1899. He was of medium height and vigorous build. The scar in the linea alba extended almost from the umbilicus to the symphysis; it was of recent appearance and was sensitive to pressure, as was also the abdomen. The patient suffered from polyuria (he was obliged to urinate at least twenty times a day) and constipation. The left lower extremity was swollen and edematous, and there was cyanosis of the foot and of the lower part of the leg (probably due to pressure on the left external or common iliac vein). The abdomen and the left leg were supported by bandages. Full capacity for self-support was restored in about four months.

Case of lesion of the bladder and urethra. Operation was followed by recovery except for persistent polyuria.

A painter, thirty-five years of age, was precipitated from a scaffolding, the latter giving way on April 25, 1890. The testicles and urethra were injured by a broken board, which also pierced the abdomen, causing a lesion of the bladder. An operation was undertaken a few hours later in the hospital. The scar left by the incision is still very apparent; it is three centimeters wide, rather thick, adherent, and fixed. It is also sensitive to pressure. The patient suffers from



persistent polyuria. His allowance was at first estimated at 45% ; for the past two years it has been 25%.

Case of severe contusion of the urethra due to a fall. Followed by stricture and albuminuria.

A workman, twenty-five years of age, fell into a trench on November 28, 1893, sustaining a severe contusion of the urethra, which required operation. Since recovery he has suffered from stricture, polyuria, and frequent attacks of albuminuria. Insurance allowance, 50%.

9. HERNIA.

The external protrusion of any part of the intestine out of the abdominal cavity or its escape into another body-cavity is called a hernia. The existence of an opening in one of the walls bounding the abdominal cavity is an essential factor in the occurrence of a hernia. The opening in the muscular or fibrous tissue composing the abdominal wall may be congenital or acquired, or it may be produced by traumatism. Certain natural openings exist for the passage of nerves and vessels, and for the passage of the spermatic cord in males and of the round ligament in females. These openings, however, do not permit the escape of the intestines unless for some reason they become stretched or enlarged. Subcutaneous rupture may occur at any point of the abdominal wall as a result of traumatism, and it is with the hernias that originate thus that we are here concerned.

Case of ventral hernia caused by falling from a scaffolding and striking on the abdomen. Sequel, traumatic peritonitis.

A painter, forty-four years of age, fell from a scaffolding, October 26, 1890, striking on the abdomen and the right hand. He sustained a fracture of the right radius and a severe contusion of the abdomen, followed by peritonitis. He was treated in the hospital for six weeks. While there, a diagnosis was made of hernia, which had descended in consequence of the fall. I examined the patient on January 24, 1891. I found a hernia in the linea alba, about a hand's-width below the ensiform cartilage. It was about the size of a fist. From the hernia one could trace a movable, rather thick cord, which extended obliquely across to the lower border of the ribs in the left axillary line. An insurance allowance of 60% was made, on account of the pain caused by stooping and because of the inability of the patient to lift anything from the ground. The connection between the traumatism and the hernia was conceded.

Case of traumatic umbilical hernia due to muscular strain.

A stone polisher, fifty-two years of age, stout, on September 15, 1891, in lifting a very heavy block of stone felt an intense cutting pain in the region of the umbilicus, accompanied by the sensation of something having been forced out of his abdomen. On examining the latter he discovered a soft tumor, the size of a cherry, which protruded again every time it was pushed back. The physician whom he consulted diagnosed an umbilical hernia. The insurance allowance was estimated at 10%. By the 12th of January, 1893, the hernia had increased to the size of an apple. Since that time it has not grown larger, and is held back by an abdominal bandage. The patient complains of painful defecation and obstinate constipation, and of vertigo on stooping. He is unable to lift even moderate weights, and is occasionally obliged to interrupt his work on account of an exacerbaton of the symptoms.

Case of ventral hernia (hernia lineæ albæ) with operation and consequent transverse division between the muscles of the abdominal wall.

A workman, sixty years of age, sustained a trivial contusion-wound in the left inguinal fold and was taken to a hospital. While there he was operated upon for a ventral hernia of long standing, which occasioned respiratory and digestive disturbances. After the operation his symptoms increased, and he demanded compensation. He subsequently received an allowance of 30% from the State Insurance Bureau. On coughing, the hernia protruded through the interval between the muscles.

Traumatic Inguinal Hernia.

Inguinal hernia is very frequently seen in working-men. It usually occurs as a single lesion, although double inguinal hernia may also be met with. Among the large number of acquired inguinal hernias that I have seen in an accident-practice of thirteen years' standing I have met with only thirty-one cases of the traumatic form.

By the term inguinal hernia we understand the hernial tumor that, entering the inguinal canal through the internal abdominal ring, remains in the canal in the form of an interstitial hernia, or escapes through the external abdominal ring to the surface of the body, either appearing as a tumor at that point or passing down into the scrotum to become a serotal hernia.

Inguinal hernia may be direct or indirect. In the indirect form, which is that most often seen, the hernia follows the course of the inguinal canal,—or, in other words, the course of the spermatic cord,—either remain-

ing in the canal as an interstitial hernia or passing out of the external abdominal ring to descend to the scrotum, there to form a scrotal hernia.

In the direct form the hernia forces its way through part of the thickness of the abdominal wall, and enters the inguinal canal on the inner side of the epigastric artery, passing through only a part of the canal on its way to the external abdominal ring. Its course, therefore, is from behind directly forward.

The inguinal canal may be stretched and enlarged by a single traumatism, sometimes in consequence of a tear in the inguinal ring. Its enlargement, however, is usually to be ascribed to atrophy of the preperitoneal fat, occurring most commonly in old persons, as a result of which the natural openings in the abdominal wall appear stretched. Folds of the peritoneum that have become relaxed around the opening are forced into it by abdominal pressure, and if the intestine follows this peritoneal sac, the development of the hernia is complete.

The escape of the intestine into the opening may occur as a result of muscular exertion, such as heavy lifting, or simply from coughing or sneezing. The process does not necessarily cause pain; on the contrary, it often gives rise to no symptoms whatever and is quite unknown to the patient. This is the rule in nontraumatic cases. Pain is felt, however, in cases of traumatic hernia when the inguinal ring is suddenly stretched or torn, or when the hernia becomes strangulated; it is upon these conditions that compensation is mainly based. We shall have occasion to refer again to this point. Inguinal hernia may, as already stated, occur on one or both sides; a double hernia, however, is rarely of traumatic origin.

A hernia must be distinguished from a protrusion of the abdominal wall in the region of the inguinal canal, accompanied by pathologic enlargement of the external abdominal ring, which is seen on expiration, and which is due to local weakness of the abdominal wall. This con-

stitutes a predisposition to hernia. Kaufmann defines this predisposition as an enlargement of the external abdominal ring, the inguinal canal, and the internal abdominal ring, and a diminished resistance of the anterior wall of the inguinal canal.

A careful differential diagnosis must be made between a predisposition to hernia and an interstitial hernia. The latter appears in the course of the inguinal canal as a flattened tumor which does not pass through the external abdominal ring. This form of hernia usually causes the most marked symptoms and is most exposed to the danger of strangulation at the internal ring.

An inguinal hernia may, as regards its size, be as small as a pigeon's egg, or it may form an immense tumor reaching down to the knee. The chief symptoms are local pain and general abdominal pain. The danger of strangulation is always present. While small hernias, especially of the interstitial variety, may give rise to considerable pain and discomfort, large scrotal hernias usually cause no trouble whatever, unless they are so large as to be painful by reason of their weight.

Intense pain is caused, as a rule, by the sudden development of an inguinal hernia in cases of traumatism. Very often we find swelling and inflammation of the abdominal wall at a point corresponding to that at which the hernia escaped; if this diagnostic sign is not present, it is often impossible to differentiate between a recent hernia and one of long standing. We can not always judge of the age of a hernia by its size. An interstitial hernia the size of a walnut may have existed for years; but, on the other hand, we are justified in assuming that a large scrotal hernia is not of recent origin. A hernia of long standing is indicated by thickening of the sac and its coverings and by a large opening.

While these points go to prove the age of a hernia, the fact that the tumor is small and flattened does not by any means signify that it is of recent development.

Although in many cases a hernia, even if of large size, may exist for years without causing any pain or inconvenience, the individual sometimes remaining ignorant of his condition, the suffering that is experienced in other cases justifies the declaration of Koenig that hernia is "a widespread disorder, limiting the working capacity of mankind, and frequently leading to the most serious consequences."

Treatment of Inguinal Hernia.

If after a hernia is properly reduced, it can be held in position by a well-fitting truss, this apparatus affords the patient great relief and reduces the danger of strangulation to a minimum. A radical operation is to be advised, however, if the hernia continues to be troublesome at times in spite of a truss, and it is always indicated in case of irreducible strangulated hernia. A truss or a suitable bandage should be worn after operation, even if this is quite successful, as the hernia may otherwise reappear after a time. In addition to keeping the truss in good condition, the patient should see that his bowels act regularly, and should avoid abdominal strain and the carrying of heavy weights.

Compensation for Inguinal Hernia.

The State Insurance Bureau allows insurance for an inguinal hernia of long standing, the descent of which is due to traumatism, as well as for a recent hernia of sudden traumatic development. A predisposition to inguinal hernia does not constitute a claim for compensation.

According to the sense of the Accident Insurance Law, the essential fact in determining the payment of indemnity is not an existing tendency to inguinal hernia, but the so-called descent of the hernia : *i. e.*, descent of a portion of the intestine through the hernial opening of the inguinal canal.

The descent of an old hernia is regarded by the Insurance Bureau as unfavorable to the physical condi-

PLATE 14.

Cicatrix Following Operation on a Case of Strangulated Inguinal Hernia.

A stonemason's apprentice, eighteen years of age, in lifting an iron beam produced a strangulation of the right inguinal hernia from which he already suffered. He was operated upon in the hospital. After recovery he complained of a marked feeling of tension in the cicatrix and of pain on coughing or sneezing or on attempting to lift heavy weights. He at first received 40% allowance, which was later reduced to 20%. Coughing caused the scar and the surrounding tissues to protrude. The patient wears a truss.

tion of the affected individual. The attitude of the State Insurance Bureau is justified by the fact that the working capacity of a man who depends for his living on muscular exertion is invariably diminished by the descent of an inguinal hernia. He is obliged to wear a well-fitting truss and to see that it constantly retains the hernia, not only in order to avoid the suffering and discomfort consequent upon the descent of the hernia, but also to obviate the danger of possible strangulation. The State Insurance Bureau also takes the position that it is of no consequence whether or not it is possible for an inguinal hernia to develop suddenly in consequence of traumatism.

The conditions under which the existence of an accident justifying indemnity are recognized are, according to Kaufmann, the following —

I. Actual accidents ; such as :

1. Direct physical violence in the hernial region.
2. Slipping or falling when lifting or handling heavy weights.

II. Unusual exertions ; for example :

1. Work that must be done under unusually unfavorable conditions.
2. Exertion to which the workman is unaccustomed.
3. Exertion exceeding the limits of ordinary industrial labor (unusual exertion in respect to the age and strength of the workman).



"To justify the payment of insurance the hernia must be developed suddenly and be accompanied by intense pain. . . .

"The sudden development of a hernia invariably causes pain of a character so intense as to be almost unbearable, to which the affected individual involuntarily gives expression, and which obliges him to interrupt his work, and to consult a physician at once. . . .

"If no proof of this kind is forthcoming, it is to be presumed that the work, during the performance of which the descent of the hernia occurs, furnishes the occasion for the same, but does not act as its cause, and is, therefore, to be regarded as the cause leading to the discovery of the condition, not as the cause of the hernia itself." ("Manual of Accident Insurance.")

When a hernia becomes strangulated as the result of professional work, the accident is entitled to be considered as the cause in the sense of the law. It is, therefore, to the interest of the affected individual, in respect to a subsequent application for indemnity, to call medical aid at once, or, at the latest, on the following day.

The average insurance allowance for an inguinal hernia the retention of which is satisfactorily guaranteed by a truss is 10%. A hernia that continues to be painful calls for a higher rate.

In examining a case of inguinal hernia the following points are to be noted :

1. External location and structure of the hernia.
2. Condition of the hernial opening ; size and condition of the abdominal ring or of the inguinal canal.
3. Sensitiveness to pressure on the inguinal canal or abdominal ring.
4. Reducibility of the hernia when the patient is standing.
5. Reducibility when the patient is prone.
6. Test of retention of hernia by a well-fitting truss.
7. Careful history in regard to traumatic origin.

PLATE 15.

Case of a Large Abdominal Hernia of the Right Side Occurring at the Site of a Deep, Funnel-shaped Scar.

A hod-carrier, twenty-seven years of age, addicted to drink, sprang backward from an insecure plank into a trench, striking on the sharp handle of a spade. The handle pierced the antero-external part of the right thigh, passing under Ponpart's ligament, and coming out just above the anterior superior spine of the ilium. The patient was treated in the hospital until December 7, 1886. I examined him on January 6, 1887. He was a large, vigorous man. In the right side of the abdomen there was a large, broad, funnel-shaped scar, which extended deeply into the tissues. There was a second smaller scar on the antero-external aspect of the right thigh. The left side of the abdomen appeared decidedly distended. The patient felt well. Insurance allowance, at first, 30%. About six weeks later I was hurriedly summoned to the house, and found in place of the funnel-shaped scar a hernia, as shown in the illustration. I had reason to believe that the hernia was caused by violent peristalsis. He complained of abdominal pain and of pain in the right thigh, which he was unable to move freely. I ordered rest in bed, compresses, and careful diet. The insurance allowance was thereafter reckoned at 50% for three years, when it was raised to 100% on the ground of a certificate from an official examining physician. The man died in July, 1895, of chronic nephritis.

Femoral hernia, although usually an acquired lesion, may also develop as a result of traumatism. The insurance allowance is the same as in cases of inguinal hernia.

Umbilical hernia is, as a rule, congenital or acquired, and is frequently observed in stout people with thick abdominal walls. Occasionally, the lesion is traceable to a trauma, such as a severe contusion, and, as a rule, in the class of people most subject to the acquired form. An umbilical hernia usually disables the patient to a greater extent than does an inguinal hernia, and it is often difficult to apply a suitable truss, especially in case of stout people. Ventral or gastric hernia also occurs in consequence of traumatism, although by some—by Rinne, for instance—this is denied. Witzel, on the other hand, asserts that one-half of all ventral hernias are of traumatic origin. The possibility of their development after traumatism is proved by a number of my own cases. The





symptoms are pain in the stomach, indigestion, respiratory disturbances, etc. The patients are unable to carry heavy loads, and should be prohibited from doing hard work. Insurance allowance, $33\frac{1}{3}\%$ to 50% . Ventral hernia may appear below the region of the stomach; it gives rise to practically the same symptoms in all situations.

Case of traumatic inguinal hernia of the left side.

A hod-carrier, twenty-one years of age, when carrying a hod full of lime on his left shoulder was about to step from a ladder to a scaffolding. At that moment, when his right foot was already on the scaffolding, and as he was about to lift his left from the last rung of the ladder, the latter slipped to one side. This caused a sudden strain, immediately followed by intense pain in the left inguinal region. Medical aid was at once obtained, and an inguinal hernia was diagnosed. The treatment consisted of rest and the subsequent wearing of a truss. When I examined the patient, I found a small hernia the size of a walnut; on palpation, the external abdominal ring felt notched, and was very sensitive to pressure. The patient was allowed 20% insurance on the ground of the sensitiveness of the lesion.

[The attitude of the German law in disregarding the predisposition to hernia and in granting indemnity when hernia directly follows traumatism in the hernial region is judicious. Although it is true that a traumatic protrusion of the gut rarely, if ever, occurs, except in the case of wounds, without a congenital or acquired weakness in the hernial region, it would be going rather beyond the mark to insist on this point in awarding damages. On the other hand, there is no doubt that, in this country at least, fully developed hernias are often alleged to be the result of an accident when in reality they existed before the accident. To obviate this, many corporations now, before accepting candidates for employment, insist on their physical examination with especial reference to the various hernial regions.—ED.]

V. INJURIES AND TRAUMATIC DISEASES OF THE UPPER EXTREMITY.

I. THE SHOULDER.

Remarks on the Function of the Shoulder.—Although only a very limited degree of motion is possible at the acromioclavicular articulation, the latter assists the shoulder-joint in the elevation of the arm above the horizontal.

The shoulder-joint is a ball-and-socket joint, and allows of rotation around numerous axes, all of which cross one another at one point. This joint consequently enjoys a wide range of motion, which, however, is to a certain extent limited by the anatomic relations of the shoulder, in particular by those existing between the shoulder-joint and the acromion process.

The head of the humerus is held in its socket by atmospheric pressure and by the deltoid muscle, assisted by the supraspinatus. The capsule of the joint is very thin, and is too relaxed and roomy to be of service in this respect. With the arm hanging by the side the lower part of the capsule is relaxed and folded on itself; it becomes tense when the arm is elevated, while the upper part of the capsule is thereby relaxed.

The action of the muscles is somewhat different. When the arm is hanging down, the deltoid and supraspinatus are put on the stretch, while, if the forearm is at the same time extended, the triceps and the scapular muscles are relaxed. When the arm is raised to a level with the shoulder, the deltoid and supraspinatus are found to be contracted, and the triceps and scapular muscles are put on the stretch. Further discussion of these points would exceed the purpose of these remarks, which is simply to indicate in brief the position of the muscles in the different attitudes of the shoulder.

The arm can be elevated at the shoulder-joint until the humerus comes in contact with the acromial process; the angle thus formed is usually one of ninety degrees. Further elevation is accomplished by rotation of the scapula, while the outer end of the clavicle moves backward and upward. The arm can not in all cases be raised to the horizontal without rotation of the scapula. According to my observations on working-men between twenty and thirty years of age, the scapula is usually called into play when an angle of from seventy-five to eighty-five degrees is reached.

The arm is raised to a level with the shoulder by the deltoid, aided by the supraspinatus, the latter part of the movement being accomplished with the assistance of the serratus magnus. This draws the lower angle of the scapula slightly forward and outward, while the trapezius either holds the upper part of the scapula firmly in position or draws it toward the spine. This involves motion at the acromioclavicular articulation. According to Gaupp, the arm is at the same time drawn slightly forward by the biceps and the coracobrachialis, which, therefore, must also be considered to take part in the elevation

of the arm. Elevation of the arm above the horizontal takes place to a considerable extent at the acromioclavicular articulation, the acromial end of the clavicle being drawn back by the trapezius, while the serratus magnus draws the scapula forward and rotates it upward. The inferior angle of the scapula is thereby made to move from behind forward in a circle the convexity of which is directed downward.

The final elevation of the arm to a vertical position is executed at the sternoclavicular articulation; the clavicle rotates in its long axis, so that the anterior margin comes to be directed upward.

In raising the arm above the horizontal the trapezius is assisted by the levator anguli scapulae and the rhomboid muscles, especially the rhomboideus minor.

The arm is elevated anteriorly by the trapezius, the levator anguli scapulae, and the pectoralis major (adduction), the scapula being rotated at the same time by the serratus magnus.

The shoulder as a whole is raised by the levator anguli scapulae and the upper and middle fibers of the trapezius, aided in certain cases by the sternocleidomastoid. The shoulder as a whole is depressed by its own weight; the pectoralis minor and the subclavian muscles may also be called into play. It is carried forward by means of anterior rotation of the scapula and the acromioclavicular joint, the movement being produced by the action of the serratus magnus, by the anterior fibers of the trapezius, and, doubtless, also by the pectoralis minor. During this movement the inner margin of the scapula is drawn away from the spine. In carrying the shoulder backward the inner margin of the scapula approaches the spine and the acromioclavicular joint moves backward. The muscles concerned are the middle and inferior fibers of the trapezius, the rhomboidei, and the latissimus dorsi.

Limitation or loss of the functional action of the shoulder-joint is due to:

1. Primary causes, consisting of pathologic processes or changes in the shoulder-joint itself.
2. Secondary causes, consisting of pathologic conditions of structures external to the joint.

The primary causes include acute and chronic inflammations, adhesions, contractures, ankylosis, paralyzes of the nerves and muscles of the joint, relaxation of the capsule (loose-jointedness), etc. To the secondary causes belong cicatricial adhesions of neighboring structures; fixation of the head of the humerus in a position of subluxation after fracture of the latter, accompanied by displacement of the broken ends; displacement of the shoulder-joint in consequence of fracture of the clavicle, scapula, or elbow-joint; central paralyzes, etc.

Statistics.—The following sections are based on an experience with 1671 injuries of the upper extremity. Of these, the shoulder-joint was involved in 312, the arm in 167, the elbow-joint in 103, the forearm in 261, the wrist in 87, and the hand, including the fingers, in 721 cases.

1. Contusions of the Shoulder and Shoulder-joint.

Remarks Regarding Examination.—In examining a patient we should begin by a careful inspection of the affected shoulder, comparing it with the normal side: first with the arms hanging down, then held level with the shoulder, and subsequently in other positions, care being taken that the arms exactly correspond in position. The anterior and posterior aspects of the shoulder and the position of the clavicle, scapula, etc., should all be carefully determined in succession.

Contusions of the shoulder or of the shoulder-joint were represented by 159 of my cases.

Falls, kicks, blows, and objects falling from above or from the side may involve the whole shoulder or only its outer end, or, in other words, only the shoulder proper or shoulder-joint. Much depends, in regard to this point, on the kind of force at work and on the direction in which it acts, as well as on its intensity.

The whole shoulder is usually involved when it is injured by being caught and crushed between moving objects, or when heavy material falls upon the prone body, or in cases of injury due to a caving-in. The shoulder-joint is alone affected, on the other hand, in most cases of traumatism caused by blows from objects falling in a vertical line.

The injury may amount simply to a contusion, or may be more severe, according to the degree of violence and the place to which it is applied. Among the cases of contusion coming under my observation I have found many fractures, dislocations, and paralyses, and occasionally lacerations of the muscles. Neither are the consequences of the injury confined to the part immediately involved; the clavicle, for instance, may be dislocated at its sternal end by a fall on the shoulder. Thus, 28 of my cases were followed by paralysis, while in 19 cases there was a fracture of the scapula and in 18 a dislocation at the acromioclavicular articulation.

In light cases of simple contusion of the shoulder or shoulder-joint healing usually takes place very quickly; in some individuals it is a question of only a few days,

while in others recovery is not completed for a number of weeks. If properly treated by compresses, early massage, and exercises, the pain disappears, the exudation is soon absorbed, and the patient is often ready to resume work in a few weeks. Recovery is delayed by complications or when the joint is kept at rest for too long a time. Long-continued fixation leads to ankylosis, which is, however, only of permanent nature in case of old persons or in those affected by some constitutional disease.

Leaving fractures, dislocations, and paralyses out of consideration, the effect of the contusion is spent on the skin, muscles, fasciæ, capsule, tendons, and bursæ.

After the extravasation is absorbed and the inflammation is subdued certain symptoms remain, which, if severe, may call for after-treatment, but which, if only slightly marked, do not prevent the patient from resuming work. They are as follows: more or less atrophy of the deltoid, possibly also of the trapezius and the muscles of the arm and chest; limited mobility of the shoulder-joint; pain on forced movement; cracking sounds of more or less intensity; and a feeling of weakness in the arm. In some cases displacement—fixation of the arm in pronation or supination—is also seen as a result of the growth of adhesions.

The average insurance allowance is about 25%, which can usually be reduced or discontinued three months after the accident. Occasionally, life-long compensation is demanded, when the patient is old or delicate or rheumatic, or when the injury is followed by some serious disorder.

Case of crushing of the left shoulder caused by the caving-in of the side of a trench. Sequels, paralysis of the brachial plexus; trophoneurosis of the hand.

A workman, fifty-two years of age, was injured on July 20, 1898, by the caving-in of the sides of the trench in which he was working. He was treated for two weeks with innervations, and subsequently by electricity. I examined him on October 7, 1898. His left arm could not be raised at the shoulder-joint, and its extreme elevation equaled only seventy-five degrees. The muscles of the left shoulder and of the left side of the chest were atrophied. There was a noticeable edematous

swelling of the left hand, which symptom had not appeared until two weeks after injury. The finger-joints were thickened, and the hand could not be closed. The parts supplied by the median and ulnar nerves were paralyzed. (See Plate 30, Fig. 2.) The patient was treated by me until the beginning of September, 1899. At that time he showed marked improvement; he could close his hand three-fourths, and could raise the arm at the shoulder-joint to an angle of 155 degrees.

Injuries of the bursæ prolong the course of treatment to a considerable extent. When the acromial bursa is involved, it appears as a small, sharply rounded tumor on the acromion process. This condition is often seen in porters; it causes, however, very little trouble. Inflammation of the subacromial bursa is said by Dupley to lead to a hyperplasia of the fibrous tissue of the brachial plexus, and thereby to neuritis of the latter. The subcoracoid bursa is probably also involved in this process. The symptoms are as follows: sensitiveness to pressure under the acromial and coracoid processes and upon the acromial insertion of the deltoid; pain on forced movement of the shoulder; movement of the whole shoulder takes place when the arm is abducted above an angle of forty-five degrees (Thiem).

When the subdeltoid bursa or the bursa of the bicipital groove is concerned, the chief symptom is pain on movement of the shoulder or arm.

Injuries to the subscapularis bursa are of special importance because of the danger of extension of the inflammation to the capsule of the shoulder-joint with which the bursa is connected. A prolonged course of treatment is usually necessary in such a case; the muscles of the whole shoulder atrophy, and the mobility of the shoulder-joint is restricted for a long time—at first on account of pain; later, on account of adhesions formed within the joint.

Among other symptoms observed after recovery from bursitis belong the loud cracking sounds produced by movement, especially when the bursa situated at the superior angle of the scapula is involved. The sounds are often audible at a considerable distance, but are not of

any functional significance, the usefulness of the joint remaining unimpaired. This is true, indeed, of chronic bursitis in general.

2. Sprains of the Shoulder.

Among my cases there were twenty-two of uncomplicated sprains of the shoulder.

Sprains due to falls or blows on the shoulder, elbow, or hand may involve either the whole shoulder, or the shoulder-joint or acromioclavicular joint alone. The same is true of the lesion when caused by suddenly catching at an object, by vigorous pulling on an object that is firmly fixed in place, etc.

The following symptoms are common to all forms of sprain of the shoulder in the later stages of the injury; limitation of mobility of the shoulder-joint, cracking sounds on movement, pain (this may be lacking), and atrophy of the muscles.

Sprains of the Acromioclavicular Articulation.

The effects of this lesion may be limited to the stretching and straining of the acromioclavicular ligaments, possibly causing partial laceration of the latter, or may be extended also to the acromial and subacromial bursæ. If the ligament is only slightly torn, the mobility of the joint is seldom permanently impaired. Acute bursitis is followed by chronic inflammation, shown by the cracking sounds already referred to, which are most noticeable when the subacromial bursa is involved. As a rule, this condition causes only slight functional disability; this is largely an individual matter, however, and in some cases a temporary insurance allowance of 20 % is indicated.

3. Fractures of the Clavicle.

Of this lesion seventy-four cases have come under my personal observation.

Fractures of the clavicle are quite a common form of injury ; in surgical text-books they are stated as constituting 15 % of all fracture-cases. As a rule, they are caused by indirect violence ; but direct fractures also occur at any part of the bone—most frequently at the outer end.

Direct fractures of the outer end are due either to blows from falling objects or to falls on the shoulder. The indirect form is usually produced by falls on the hand when the forearm is extended.

The most common seat of fracture is the middle third of the bone, or a point between the middle and outer thirds, the lesion being due, as a rule, to indirect violence,—such as a fall on the hand with extended forearm, or a fall on the shoulder,—or, less frequently, to the strain of lifting heavy weights.

Fractures of the inner third are of comparatively infrequent occurrence. They are caused by indirect violence, usually by violent contraction of the sternocleidomastoid.

Symptoms of Reunited Fractures of the Clavicle.

—In order to gain a clear understanding of the displacements consequent upon fracture of the clavicle it is necessary to think of this bone as a brace between the sternum and the acromion process of the scapula. It is easy to see that a fracture accompanied by displacement of the broken ends must necessarily involve an abnormal position of the scapula, of the humerus, and, indirectly, of the head also.

Of the symptoms of fracture of the clavicle with which we have to deal after union has taken place, those described below are of most frequent occurrence.

At the point of fracture there is a more or less marked callus-tumor, which diminishes in size in the course of time, and may entirely disappear after a few years. In some cases the callus is not perceptible externally ; we find, instead, a pointed or sharp-edged prominence, consisting of one of the fragments of the fractured bone over-

lapping the other. As a rule, the inner fragment overlies the outer. This displacement of the fragments has the effect of shortening the clavicle, and, consequently, the position of the shoulder is altered. The scapula adapts itself to these new conditions by rotating on its long axis, the external margin turning forward, while the head of the humerus, in following the change of position, rotates slightly inward. When both arms are placed on a level with the shoulder, with the thumbs turned upward, the bicipital aspect of the arm is seen to be directed downward, while the olecranon process looks upward. The shortening of the shoulder and the deformity due to inward rotation are clearly seen in this position. In typical cases of fracture in the middle third of the clavicle the shoulder is depressed.

When the inner fragment is displaced forward, the sternocleidomastoid becomes very prominent and draws the head slightly to the side, making the neck appear shortened on the side of the fracture, and lengthened on the opposite side (*caput obstipum*).

The trapezius, as well as the muscles of the shoulder, chest, and arm of the injured side, give evidence of atrophy, in consequence of which the shoulder frequently has a pointed appearance.

The mobility of the shoulder-joint is restricted, the movements of elevation of the arm above the shoulder and of rotation outward and inward being especially affected. Movement may continue to cause pain for some time, and neuralgic tenderness can sometimes be traced down to the ends of the fingers. Cracking sounds are often produced at the shoulder, and the whole upper extremity remains weak for a time.

The deltoid is sometimes paralyzed as a result of direct contusion.

Case of reunited fracture of the right clavicle at its outer end, with displacement of the outer fragment into the suprascapular fossa.

A painter, fifty-four years of age, was crushed between a truck and

PLATE 16.

Case of Reunited Fracture of the Left Clavicle in Its Middle Third.

A mason, twenty-four years of age, fell from a height of one story on September 13, 1897, sustaining a fracture of the left clavicle. He was treated in the hospital for some weeks. I examined him on October 16, 1897. He had been incapacitated for work for exactly four weeks.

In the illustration the displacement of the sternal fragment forward and upward and the marked elevation at the point of fracture are shown. The sternocleidomastoid is distinctly seen, and the head is somewhat inclined to the left. The left shoulder and left arm are slightly rotated inward, and there is evidence of atrophy of the muscles of the left shoulder and arm. The shoulder appears a little shortened. At the time the patient came to me for examination he was able to raise his left arm at the shoulder-joint to an angle of 140 degrees. He undertook light work at first and complained chiefly of pain on movement of the left shoulder and of inability to use the latter for carrying purposes. He was allowed 20% insurance. At the present time he is unable to raise his arm above an angle of 160 degrees.

a wall. He sustained a fracture of the right clavicle and fractures near the spine of the third to eighth ribs inclusive. He was treated in the hospital for several weeks. I examined him July 17, 1896. He was of medium height. Face rather pale. The deformity of the right shoulder was very evident; of the clavicle, only the larger sternal fragment was visible, while the acromial process was sharply defined. On palpation a fibrous cord could be felt, passing from the acromial process to the outer third of the clavicle, while part of the outer fragment lay in the supraspinous fossa, which it filled. The muscles of the scapula, the back, and the whole shoulder were much atrophied, and the shoulder appeared to be displaced backward. The patient could not raise his right arm above an angle of thirty-five degrees; on passive motion it could be carried with great difficulty to an angle of sixty-five degrees and caused the patient a great deal of pain.

The movement produced cracking sounds in the joint. The scapula was called into action before thirty-five degrees were reached. The sternocleidomastoid was displaced forward, and the head was slightly inclined to the right side. After a further course of treatment the patient was discharged from my clinic on April 26, 1897, receiving 50% insurance allowance. He was then able to raise his arm with ease to an angle of 115 degrees, and could carry it to 145 degrees with effort. The pain had greatly diminished. The skiagraph clearly shows the displaced outer fragment of the clavicle, the acromial end of which lies close to the coracoid process. The points of fracture of the ribs near



the spinal column, showing their upward dislocation, can also be recognized.

When the patient entered my care he complained of pain in the chest and on stooping, which disappeared, however, by January, 1897. In September, 1897, the patient was allowed 35% insurance; in September, 1898, this was reduced to 25%. At that time the arm could be raised voluntarily to an angle of 150 degrees, and on passive motion to 160 degrees.

In comparatively rare instances we may meet with paralysees of the brachial plexus due to direct injury.

[Symptoms referable to the brachial plexus resulting from injury to the shoulder are not so very rare, and are often puzzling. They result from direct violence, such as blows or falls, with or without fracture or dislocation of bone, rather than from the slow pressure of callus. The musculospiral and ulnar are the nerves most frequently involved in injuries around the shoulder-joint, although paralysis of the circumflex or the median or the musculocutaneous may be added. The symptoms of these combined paralysees are the sum of the symptoms of palsy of the individual nerves. They are usually the result of severe injuries, and the prognosis is accordingly serious.

Injuries to the neck, falls upon the point of the shoulder, and, less frequently, dislocations of the shoulder sometimes cause a peculiarly distributed paralysis, first described by Erb, and often called Erb's palsy. The muscles most frequently affected are the deltoid, biceps, brachialis anticus, and supinator longus. The supraspinatus and infraspinatus may also be involved. (Then there is an inward rotation of the arm.) All these muscles, with the exception of the last two, receive their innervation through the fifth and sixth cervical nerve-roots. The suprascapular nerve, which supplies the supraspinatus and infraspinatus, receives some fibers from the fourth cervical segment, but as most of its fibers come through the fifth and sixth roots, it may easily be injured when these roots are affected. Hoedemaker has suggested that, in injuries to the shoulder, paralysis of these nerves may occur by

PLATE 17.

Case of Fracture of the Sternal Extremity of the Left Clavicle Leading to Ankylosis of the Shoulder-joint and Torticollis, Requiring a Prolonged Course of Treatment. Marked improvement later on.

A workman, fifty-five years of age, on July 7, 1892, fell, with the ladder on which he was standing, striking the sidewalk on his left shoulder. He was treated in the hospital for seven weeks.

The patient was a small, delicate man. The illustration shows his condition at the beginning of a course of treatment in my hospital, which lasted from October, 1892, to May, 1893. The almost complete uselessness of the left arm and shoulder was very evident at that time. In the picture the thickened prominent sternal end of the left clavicle can be seen, drawing the sternocleidomastoid forward. The head is perceptibly inclined to the left, while the acromial end of the clavicle is elevated and displaced backward. The left shoulder is shortened, the muscles of the left arm and shoulder are atrophied, and the arm is held rather close to the body. Posteriorly, the atrophy of the trapezius and of the muscles of the whole shoulder is distinctly visible.

The treatment consisted in passive movements and gymnastic exercises of the left shoulder, and in massage and electricity.

The patient was discharged in May, 1893, with an insurance allowance of 50%, which he drew until July, 1898, when it was reduced to 25%. At the present date the arm can be raised almost to a line with the body, the head is held straight, the backward displacement of the acromial end of the left clavicle has disappeared, and the arm is held in an entirely normal position. The only remaining symptom is a slight weakness of the arm.

the fifth and sixth roots being compressed between the transverse processes of the sixth and seventh cervical vertebrae and the middle of the clavicle.

In cases in which the paralysis is severe, Erb's palsy is a very disabling affection. The arm can not be raised from the side, and the forearm can not be flexed or strongly rotated outward. From paralysis of the deltoid, the shoulder of the affected side is lower than its fellow, and there may be a slight subglenoid dislocation of the humerus. Atrophy is often an early symptom, and there is usually marked fibrillary twitching in the muscles when they are put in action, if that is possible; they sometimes are completely paralyzed. The sensory symptoms are never prominent; there may be numbness and tingling in the



Fig 1



Fig 1^a

region of the shoulder or in the radial distribution of the forearm and hand. The electric reaction soon shows degenerative changes. All these muscles may, in health, be made to contract by applying the electric current at a point in the neck called Erb's point; after injury disordered electric reactions soon become manifest at this point.

The general prognosis of this form of paralysis is good, in that the patients usually recover. Recovery is, however, always tedious, extending over many months.

Another form of brachial plexus palsy, named, after its first describer, Klumpke's palsy, involves the first anterior dorsal root. Through this root pass the sympathetic fibers for the eye and face. The symptoms are paralysis of the small muscles of the hand and disturbances of the sympathetic in the face of the same side. There are myosis, diminution in size of the palpebral fissure, loss of the cilio-spinal reflex, sinking-in of the eyeball, and flattening of the side of the face. There are usually no vasomotor disturbances.

Klumpke's paralysis results from causes similar to those of Erb's paralysis, but it is much less frequent.—ED.]

Symptoms ascribable to pressure of the callus on the plexus are also observed at times. Pseudo-arthritis is another unusual sequel.

The following points call for special mention :

Fractions of the external third of the clavicle usually lead to only slight displacement, except when the bone is broken between the two divisions of the coracoclavicular ligament,—namely, the conoid and trapezoid ligaments,—and the latter are thereby lacerated. In these cases the outer fragment sometimes becomes fixed at a right angle to the inner fragment, the acromial extremity pointing upward, thereby elevating the scapula and the whole shoulder. In other cases the acromial extremity is directed downward, or it is entirely displaced and lies in the supraspinous fossa. Where such marked deformity exists, the mobility of the shoulder-joint is greatly restricted; com-

plete ankylosis may even supervene as a result of bony union with the coracoid process or with the shoulder-joint itself.

The consequences of fractures of the inner third of the bone depend to a large extent upon the action of the sternocleidomastoid. At first the head is inclined toward the injured side in order to avoid pain, and the position once taken, it is frequently retained. In addition, we find a growth of callus at the point of fracture, and in some cases partial forward dislocation of the sternal extremity of the clavicle. Further, there is atrophy of the muscles of the shoulder, neck, and chest on the injured side, and limited mobility of the shoulder-joint, movement of which produces cracking sounds. The ankylosis of the shoulder-joint is almost always due to unnecessarily prolonged fixation, to which cause contractures of the elbow-joint, frequently observed after removal of the fixation-bandage, are also to be ascribed.

Fractures of the clavicle may be further complicated by fractures of the ribs. In case of the first rib the lesion is due to direct pressure; fractures of the other ribs, however, are indirectly caused by falls on the shoulder. These complicating fractures are frequently overlooked.

The chief aim of **treatment** should be the restoration of function. Massage is particularly to be recommended if the parts are still swollen, while ankylosis is best treated by systematic passive movements and gymnastic exercises. Massage and electricity should be employed for muscular atrophy; for neuralgia, galvanism and baths are especially beneficial.

After-treatment may be indicated for a few weeks only, or, when complications exist, for a number of months. Even prolonged treatment may prove unsuccessful in unfavorable cases, the shoulder-joint remaining permanently ankylosed.

It should not be forgotten, however, in considering the

serious consequences of the injury, that working-men have been known to continue work after sustaining a fracture of the clavicle.

Case of fracture of the outer third of the clavicle in consequence of a fall from a ladder. No medical advice was obtained, work was not discontinued, and recovery took place without deformity.

A workman, eighteen years of age, fell from a ladder in 1864. Although the clavicle was fractured, he felt only slight pain and went on with his work. The fracture healed while work was continued, the bone being but little displaced. It was shortened by $1\frac{1}{2}$ cm. The functional power of the patient was unaffected. He entered the army later, and took part in the two subsequent wars.

4. Dislocation of the Clavicle.

Of this lesion fifteen cases have come under my observation.

The clavicle may suffer a **forward dislocation** at its sternal extremity in consequence of a fall on the anterior part of the shoulder, of being run over, and similar accidents by which the shoulder is violently driven backward, while the shaft of the bone, acting as a lever, forces the sternal extremity forward out of its normal position. Partial dislocations of this joint on the side supporting the load are frequently observed in hod-carriers.

The **symptoms** of forward dislocation after healing takes place are as follows: As it is almost impossible to succeed in retaining the dislocated bone in position after reduction, it remains displaced forward to a greater or less degree for a long time. The undue mobility of the joint that accompanies the displacement may persist for some years. The sternocleidomastoid is prominent, and is somewhat displaced forward, thereby causing the neck to appear shortened on that side, while the reverse effect obtains on the opposite side. The triangle formed by the sternocleidomastoid, the clavicle, and the anterior margin of the trapezius is diminished in size.

The acromial extremity of the clavicle may be directed backward and downward, or backward and upward, the shoulder being correspondingly lowered or raised.

The muscles of the chest, shoulder, and neck on the injured side show evidence of atrophy, and movement of the shoulder-joint is restricted.

All the foregoing symptoms are almost identical with those seen in cases of healed fracture of the sternal end of the clavicle.

The **symptoms** consequent upon **upward dislocation** of the sternal extremity of the clavicle in cases in which reduction is practised are usually as follows: The inner extremity of the clavicle is slightly displaced forward or upward, while the acromial end of the bone is directed backward, and is at the same time either slightly raised or depressed. The head is somewhat inclined to the injured side. The other symptoms of atrophy and diminished mobility are similar to those of the forward dislocation.

Backward displacements give rise to external appearances similar to those which have been described. They depend chiefly on the position maintained by the sternal extremity of the bone subsequent to healing. In almost all the cases coming under my observation it was slightly displaced forward, giving rise to the symptoms corresponding to that position. One patient suffered, in addition, from severe neuralgic pain in the arm, brought on by every attempt to lift the arm, and also from pain in the side of the neck on the injured side. Another case was marked by a rapid pulse and attacks of dyspnea.

The **treatment** should be directed toward attaining the greatest possible degree of motion in the shoulder-joint. When passive movements are practised, the dislocated extremity of the bone should meanwhile be carefully maintained in position. Massage and electricity are also useful in overcoming the atrophy of the muscles.

The degree to which the patient is incapacitated for self-support depends on the loss of functional power of the shoulder-joint. A course of treatment should be advised if there is difficulty in lifting the arm to the level of the shoulder, or if this movement is painful. For patients

who are thus affected an insurance allowance of from 30 % to 50 % may be indicated when the right arm is involved ; from 20 % to 40 % if the left is involved.

When the lesion occurs at the acromial end of the clavicle, the bone is usually dislocated upward. The lesion is produced by falls on the shoulder, when the acromial process receives the brunt of the injury, or by blows from objects falling on the acromion.

In cases of partial dislocation in which the acromioclavicular ligaments are partly torn, the following symptoms are noted : a slight prominence of the acromial extremity of the clavicle ; a moderate degree of rotation of the clavicle on its long axis ; atrophy of the deltoid and trapezius, and possibly also of the muscles of the chest and scapula ; pain and lessened mobility of the shoulder-joint.

The treatment is symptomatic. The working capacity of the patient is often diminished by from 10 % to 20 % or more.

Complete dislocation, involving complete laceration of the acromioclavicular ligaments, is recognized in the following manner : The acromial extremity is displaced upward and is perceptible just beneath the skin ; and it may be separated from the acromion by a distance of 2 or 3 cm. or more. It may be difficult or impossible to raise the arm, especially above the level of the shoulder. Movement is likely to bring the end of the clavicle into contact with the acromial process, causing loud crepitation and pain. The muscles are more appreciably atrophied than in cases of partial dislocation, and the condition persists for a much longer time.

Treatment.—The effect of suturing the bone in position should certainly be tried, since no other method yields results worth mentioning. Insurance allowance, 33 $\frac{1}{3}$ % to 50 %.

Downward dislocation of the acromial end of the clavicle is a rare form of injury, produced by a blow on

the outer end of the clavicle. It is accompanied by extensive laceration of the ligaments, and in some instances by fracture of the coracoid process. The force of the blow may also be extended to the head of the humerus, compressing it against the scapula and leading possibly to paretic disturbances from injury of the brachial plexus. The joint may become partly or totally powerless, movement being regained later on in some cases by gradual development of a new joint.

If reduction can be maintained, no specially characteristic symptoms are observed; if the bone remains loose in the joint, the lesion occasionally assumes the appearance of an upward dislocation.

If the dislocation remains unreduced, the acromion is seen to protrude sharply, while the outer extremity of the clavicle is concealed beneath it. The inner end of the clavicle is prominent and is slightly displaced forward at the sternoclavicular joint, the shoulder being somewhat displaced backward. As a rule, we find marked atrophy of the muscles of the shoulder, the scapula, the chest, and of the whole upper extremity, but especially marked in those attached to the humerus.

Treatment.—If still unreduced, reduction must be practised under all circumstances; otherwise, passive movements of the shoulder, massage, etc., are indicated.

The degree to which the patient is incapacitated depends on the loss of functional power.

5. Fractures of the Scapula.

Among my cases of fracture of this bone the body of the bone was involved in 19 cases; the spine in 6; the acromion process in 12; the neck, including the glenoid cavity, in 8; and the coracoid process in 12 cases.

In general, it may be stated that fractures of the scapula are rare injuries. This applies especially to the body of the bone, which is protected on all sides by thick muscles; less so to its processes; and least of all to the acromion process.

(a) **Fractures of the body** are due to falls on the back, to blows from falling objects, etc. The lesion is frequently complicated by fracture of the spine of the scapula, and still more frequently by fractures of the ribs. Occasionally, the lung is lacerated.

Symptoms after healing are not well marked; deformities are sometimes perceptible in thin individuals, but are difficult or impossible to determine in muscular or stout patients.

The muscles connected with the scapula and the adipose tissue protecting it undergo more or less atrophy, the process being frequently extended to the trapezius, supraspinatus, and deltoid.

The inferior angle of the scapula is frequently displaced, and in case of transverse fractures it is usually displaced outward.

When both arms are elevated to the level of the shoulder, atrophy of the teres minor, teres major, and latissimus dorsi becomes apparent in the majority of cases. If the fracture involves the inner superior angle of the bone, this is sometimes drawn upward by the levator anguli scapulæ. A fracture of the spine in a vertical line can occasionally be recognized by callus or by a convex nick in the bone. Functional power is but very slightly affected, although in some cases treatment is required on account of restricted mobility of the shoulder-joint.

(b) **Fractures of the acromion** are met with more frequently, and in almost all cases are due to direct violence, such as falls on the shoulder or blows from falling objects. Occasionally, they are indirectly caused by falls on the elbow, and in rare instances directly by muscular action alone. When due to direct violence, the fracture is usually seated near the apex of the acromion, whereas when the violence is indirect, it approaches its base.

After union takes place the apex of the acromion appears sharply defined, and the supra-acromial bursa is frequently found to be enlarged. Symptoms due to loss

of functional power are but slightly marked or are severe, depending on the degree of displacement of the fractured fragment. In some cases the acromion becomes completely separated from the rest of the bone and approaches the clavicle. In one case of the kind, which has been under my observation since 1895, abduction is greatly restricted, the patient still being unable to raise his arm above an angle of forty-five degrees. The external appearances in this case are identical with those of a complete upward dislocation of the acromial end of the clavicle.

Treatment is mainly a question of the restoration of functional power. The insurance allowance is estimated according to the functional disability: in very light cases none is required.

(c) **Fractures of the neck of the scapula** frequently involve the articular surface of the glenoid cavity; they are usually caused by blows or falls on or against the shoulder, on the outstretched hand, or on the elbow. The lesion is said to have occurred in consequence of violent contraction of the biceps (short head) and coracobrachialis.¹ It would seem that the only possible lesion that could thus originate in this situation would be an indirect fracture of the surgical neck, since the muscles in question contract in the direction of the coracoid process, not in the direction of the neck of the scapula. A fracture of the latter might more easily be explained on the ground of violent action on the part of the triceps.

After recovery the affected shoulder usually remains shortened, and the head is sometimes slightly inclined to that side; the acromioclavicular joint is sharply prominent, and the head of the humerus is lowered in position. If the line of fracture runs across the glenoid cavity, the mobility of the shoulder-joint remains restricted for a long time, if not permanently. The muscles connected with

¹ Hoffa, "*Luxat. u. Fract.*," 3d ed., p. 190.



Fig. 28.

the shoulder and arm become greatly atrophied, especially the long head of the triceps. Atrophy of the deltoid may also occur in consequence of paralysis of the circumflex nerve.

The **treatment** consists in exercises of the shoulder-joint, etc. The insurance allowance depends on the power of the patient to raise and use his arm; even as much as 75% may be granted.

Case of fracture of the neck of the right scapula, due to a fall into a cellar, leading to extensive adhesions and functional disorders.

A workman, thirty-eight years of age, fell into a cellar on June 30, 1894, striking on his right shoulder. He was treated at first at home; subsequently in the hospital, where, between August, 1894, and January, 1895, the adhesions in the joint were forcibly broken four times under anesthesia. The patient entered my hospital on March 1, 1895. He was rather tall and of vigorous build. The right shoulder was shortened and slightly rotated inward; the muscles of the right side of the chest, the shoulder, and the arm were greatly atrophied, those of the hand being also affected. The arm could not be raised at the shoulder-joint above an angle of eighty-five degrees, and movement was painful. The patient was discharged May 22, 1895, with an allowance of 50%, no essential improvement having been effected.

(d) **Fractures of the coracoid process** are usually seen in connection with fractures of the acromion, the spine, or the neck of the scapula; with fractures or dislocations of the clavicle or the humerus; or with fractures of the ribs. Less frequently they are caused by muscular contraction. The lesion is occasionally produced during the process of reduction of a dislocation of the humerus, but the most frequent cause is a fall on the shoulder. If healing occurs without displacement, functional power is satisfactorily restored. On the other hand, if the coracoid process becomes displaced outward, as occurs in most cases in consequence of the action of the coracobrachialis and biceps and of movements of the arm, it greatly interferes with movement of the shoulder-joint, the head of the humerus coming in contact with the process as soon as the arm is slightly raised.

Other symptoms are as follows: the groove of Mohrenheim appears flattened; the coracoid process is displaced

and sensitive to pressure at first; the displacement and the callus together cause it to feel enlarged and thickened. The clavicle and scapula may also be slightly displaced; the biceps (short head), coracobrachialis, and pectoralis minor invariably show signs of atrophy, which secondarily involves the pectoralis major as well. In severe cases the injury leads to paralysis of the brachial plexus.

The **treatment** consists in mechanical exercises of the shoulder-joint, in massage, and in the use of electricity. Operation is indicated for cases in which movement of the head of the humerus is mechanically prevented. The incapacity for self-support depends on the loss of functional power. On an average, it equals 30%; for complete ankylosis of the shoulder-joint about 75% insurance is allowed.

Case of fracture of the coracoid process caused by distocation of the humerus. (Fig. 28.)

A workman, thirty-six years of age, addicted to drink, on August 3, 1896, fell into a cellar while drunk. He was treated in the hospital, reduction being practised immediately. He was discharged six weeks later. I examined him September 17, 1896. He was of medium height and vigorous build. The groove of Mohrenheim on the right side was flattened and filled out. The right shoulder was somewhat depressed. On palpation the right coracoid process could be felt thickened and displaced outward. On both active and passive motion elevation of the right arm was limited to an angle of sixty-five degrees. He was treated in my hospital until April 27, 1897, and discharged practically unimproved. He was allowed 50% insurance, which was later raised by legal process to 66 $\frac{2}{3}$ %.

The skiagraph (Fig. 28) very clearly shows the displacement of the coracoid process upward and outward. It is evident that the head of the humerus must strike it on abduction. The muscles arising from the coracoid process, the coracobrachialis, and short head of the biceps show corresponding displacement, and the muscles of the whole arm are markedly atrophied.

6. Dislocations of the Shoulder-joint.

The following chapter is based on seventy-one cases of this lesion occurring in my own practice.

Dislocation of the shoulder-joint is a common form of injury, occurring in about 50% of all cases of dislocation.

Of the several varieties of the lesion, the subcoracoid is most frequently met with. It is due to either direct or indirect violence, including muscular action. It may be caused by a variety of accidents: by falling on the outstretched hand or the elbow; by violently catching at a support when falling over backward; by severe blows, kicks, or falls upon or against the shoulder; or by violent movements of the arm in throwing, beating, etc.

After successful reduction recovery sometimes takes place rapidly and completely, but in other cases the results are less favorable, functional disorders remaining that require a long course of treatment, especially if complications are present. It must be stated, indeed, that the importance of the consequences of shoulder-dislocations is very frequently underrated.

After reduction and subsidence of the swelling the following symptoms can usually be observed: The injured shoulder appears atrophied, the acromion being sharply defined. Occasionally the deltoid is so greatly atrophied as to leave a deep hollow under the acromion. The muscles of the arm are invariably atrophied: if the dislocation is complicated by paralysis of the nerve plexuses, the atrophy involves, in addition, the muscles of the forearm and hand, and also those of the chest, the neck and throat, the scapula, and even the back on the affected side. This may result in the development of scoliosis. As a rule, the arm is found to be rotated inward to a moderate degree, the position being most clearly shown when the arms are placed on a level with the shoulder, the thumbs pointing upward. (Compare Fig. 29.) The pronation of the humerus involves a corresponding displacement of the biceps and of the whole shoulder, the latter also appearing shortened. The rotation of the humerus and shoulder probably depends on cicatricial contractions of the joint-capsule, and since it is most often in the subcoracoid form of dislocation that the anterior part of the capsule is lacerated, we usually find an inward rotation in these cases.

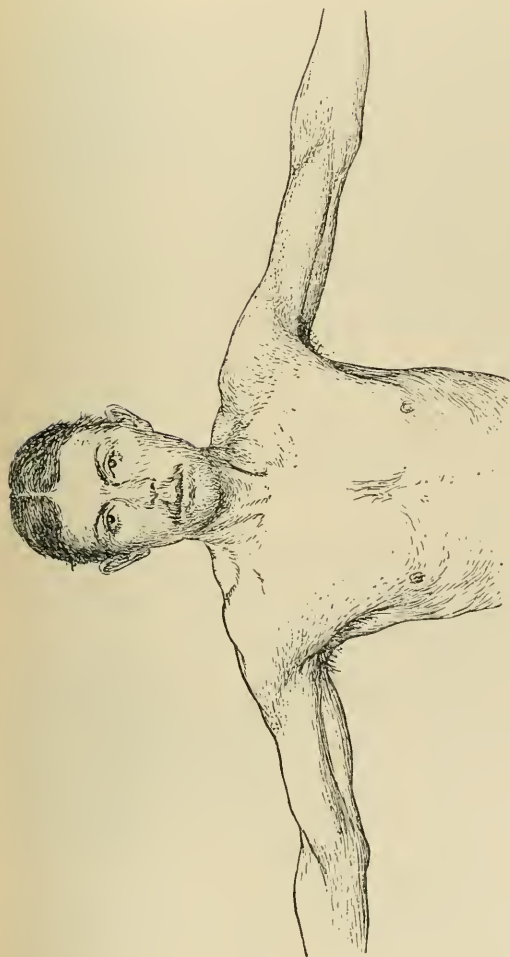


Fig. 29.—The subject of this sketch, a carpenter, thirty-two years of age, sustained a dislocation of the left shoulder-joint in 1892. The illustration shows the atrophic condition of the muscles of the shoulder, the arm and forearm, and the slight inward rotation of the arm and shoulder. The left arm can not be raised as easily as the right. Insurance allowance six months after injury, 20%.

PLATE 18.

Case of Reduced Dislocation of the Right Shoulder-joint.

Sequels, extensive adhesions in the shoulder-joint, paralysis of the brachial plexus, progressive muscular atrophy, and scoliosis.

A coachman, twenty-one years of age, fell from a carriage on October 29, 1891, thereby dislocating the right shoulder. He was treated in the hospital until November 21, 1891; he then, on several occasions, attempted to work, but was obliged to discontinue.

I examined him February 9, 1892. He was a rather small man; the right shoulder and right arm, and in part his forearm, were extremely atrophied. Abduction was almost impossible. The muscles in part showed the reaction of degeneration. He was treated at my hospital until July 1st, when he was discharged for misbehavior. His condition had not improved; on the contrary, there was a progressive muscular atrophy that finally extended over the whole right side of the chest and back. The muscles of the forearm were only slightly affected, so that the hand remained useful. He was allowed 40% insurance.

The arm could be raised (at the shoulder-joint) only to an angle of thirty-five degrees. The circumference of the affected arm measured less than that of the other, as follows: at its lower third, 4 cm. less; at the middle of the biceps, 6 cm. less; at the axilla, 7 cm. less; at the forearm near the elbow, nearly 2 cm. less.

Tuberculosis of the lungs was diagnosed in August, 1895, and the patient died one year later.

Although in some cases the direction of rotation is not clearly marked, there may nevertheless be evidence of adhesions and cicatricial contractions due to the laceration of ligaments, tendons, or muscles, or to the chipping-off of bits of cartilage or bone. It is to complications of this nature that ankylosis is often to be ascribed. Sometimes when there is no paralysis movement may be greatly restricted, so that it is hardly possible to raise the arm to a level with the shoulder, even with the cooperation of the scapula. Secondary contractures of the elbow-joint are also sometimes observed.

When bits of cartilage or bone are broken off, the callus that subsequently forms may lead to complete ankylosis of the shoulder-joint. Fracture of structures within or connected with the joint may occur at the time of injury, or during the process of reduction. In this way



Fig. 1.



Fig. 1^a



the coracoid process, the greater tuberosity, and, less frequently, the lesser tuberosity may be broken off, or the humerus may be fractured at its anatomic neck, or occasionally at its surgical neck.

The paralyses, which are very frequent sequels to dislocations of the shoulder-joint, may depend on direct laceration of the circumflex nerve or on injuries to the brachial plexus. Usually the latter is only partly involved. Paralysis of the ulnar nerve occasionally occurs as a late symptom, leading to claw-hand and to tropho-neurotic disorders. The effects of the paralysis are motor and sensory. Among the sensory symptoms are disturbances of the temperature-sense, subjective coldness, formication, etc. Electric irritability may be only depressed or the reaction of degeneration may be present. In severe cases edema and cyanosis of the arm are also observed. Pronounced loss of power in the hand is the rule, although in some cases of severe plexus-injury considerable strength is retained.

The **prognosis** as to function after recovery from dislocations attended by complications of the kind just described is unfavorable in the majority of cases. Very few patients can be discharged completely cured. The prognosis depends also on the age of the patient, becoming less favorable with advancing years. A certain amount of improvement may, however, gradually take place in the course of years, both as regards paralysis and ankylosis.¹ In case of the latter, improvement is sometimes due to the formation of a new joint.

Although **treatment** may in some severe cases prove entirely unsuccessful, its value should not for that reason be underrated, since in the great majority of cases much can be accomplished by means of systematic massage, baths, medicomechanical exercises, and electricity. This demands much patience on the part of both doctor and

¹ In the strict sense of the word, it is incorrect to speak of "ankylosis" in describing all forms of stiffness of a joint.

patient, as recovery is usually a very slow process. In severe cases the course of treatment may cover a year or more.

The insurance allowance is proportionate to the loss of functional power, and may be as high as 75 %.

Subspinous dislocations are of comparatively rare occurrence ; they are usually caused by a fall on the hand or elbow when the arm is directed forward and at the same time strongly abducted.

The symptoms subsequent to reduction differ in nowise from those of the subcoracoid variety, except, possibly, in respect to the position of the arm and shoulder. The complications of the two varieties are also identical.

Old unreduced dislocations are seldom met with in accident-practice. Even in these cases reduction should be attempted ; otherwise, treatment and prognosis are the same as for ankylosis of the shoulder in general.

Sometimes dislocation of the shoulder-joint leads to a condition of recurrent or habitual dislocation ; the head of the humerus is likely to slip out of the glenoid cavity on the slightest provocation, and it becomes necessary for the patient to wear a fixation-bandage in order to perform even light tasks, heavy work being quite out of the question. Fixation by suture, according to Ricard, is to be recommended. These cases require a high rate of insurance allowance.

Fractures of the shoulder-joint have already been referred to in one instance—that of fracture of the glenoid cavity. Fractures of the articular portion of the head of the humerus will be discussed in connection with lesions of the arm.

Case of dislocation of the right shoulder-joint, in which reduction was practised. Sequel, severe permanent paralysis of the brachial plexus.

A stone-mason, twenty-seven years of age, was injured by the caving-in of a building on April 8, 1891. He sustained a dislocation of the shoulder-joint and direct fractures of several ribs, the latter lesion being followed later on by tuberculosis. I examined him July 7, 1891. The right arm hung limp at his side, and his right shoulder was de-

pressed. From the elbow down to the ends of the fingers there were edema and cyanosis. There was marked subjective coldness of the part. Active movement of the shoulder-joint was out of the question; the mobility of the elbow-joint was comparatively well preserved. The right hand could be closed with some difficulty and could exercise no pressure whatever. The muscles of the right side of the chest, neck, and back were greatly atrophied. The reaction of degeneration was present. Insurance allowance, 100%.

Thirty-nine cases of healed fracture of the shoulder-joint occurring in my own practice have been utilized in the preparation of the foregoing description.

Traumatic Synovitis of the Shoulder-joint.

Acute traumatic synovitis of the shoulder-joint develops after contusions, sprains, dislocations, and fractures.

The **symptoms** are swelling, fever, and functional disability.

The **treatment** consists of putting the part at rest, either by ordering the patient to remain in bed or by the use of a bandage; also in the employment of antiphlogistic measures and, later on, in massage and movements of the joint.

Chronic synovitis is a sequel to the acute form. The absorption of the exudate is followed by proliferation and hypertrophy of the synovial folds; adhesions form between the latter, and, if the capsule was lacerated by the injury, it becomes involved in cicatricial contractions. The muscles and the parts of the bones concerned in the movements of the shoulder-joint all undergo atrophy. Movement is restricted, and on passive motion cracking sounds are both heard and felt in the joint. The condition is, as a rule, only slightly painful. The average insurance allowance is from 20% to 25%.

Tuberculous synovitis of the shoulder-joint develops after traumatism, usually after a contusion or dislocation; it occurs comparatively often in young people. The acute synovitis is succeeded by a purulent epiphysitis, accompanied by fever; fistulas subsequently develop and sequestra are thrown off. The treatment is purely surgical, and it may be necessary to continue it for a number of years.

The fistulas constantly break open again, and new ones form in consequence of metastatic growth, causing repeated attacks of fever and requiring frequent operations. When healing finally takes place, the part remains deeply scarred ; the unfavorable effects of the scar-tissue may, however, become modified in time. The arm remains undersized. In some cases the tuberculous process develops very slowly and insidiously, so that years may elapse before suppuration sets in.

As contractures and ankylosis of the shoulder-joint have already been referred to a number of times, it would be superfluous to discuss them here.

Loose-jointedness was mentioned in connection with recurrent dislocation.

2. INJURIES OF THE ARM.

The total number of injuries of the arm coming under my observation was 167; this number was made up as follows : 24 cases of contusion, with or without accompanying wounds; 5 cases of muscle strain; 8 of subcutaneous rupture; 54 fractures; 71 dislocations of the shoulder-joint; 2 wounds caused by bites; 2 punctured wounds. The right arm was involved alone in 94 cases, the left in 72 cases; in one case both arms were injured.

1. Contusions of the Arm.

Slight contusions caused by blows, kicks, or falls usually heal quickly and completely. On the other hand, when the arm is severely crushed, as in accidents due to cavings-in, etc., recovery is slow. In such cases the soft parts—the skin, fasciæ, muscles, vessels, and nerves—are all more or less crushed and torn. Extensive laceration of the muscles leads to atrophy and loss of functional power, while the injured nerves remain inflamed (neuritis) or paralyzed for a long time.

2. Wounds of the Arm.

Simple lacerated or punctured wounds, unless followed by cellulitis, are of little importance. Wounds of large

size lead to cicatrices that, if deeply attached or much retracted, interfere with the functional action of the part. Deep wounds of the axilla are especially dangerous, and the resulting cicatrices are likely to prevent free abduction of the arm. Extensive scars on the posterior surface of the arm may similarly restrict the action of the elbow-joint.

Wounds caused by bites are serious injuries, not only because of the irregularity of the wound and the danger of infection, but also because they are likely to lead to unfavorable conditions of the injured parts of the skin and muscles, and to paralysis of the nerves involved. In one patient of mine, a coachman, who was bitten by a horse, there was paralysis of the radial and median nerves requiring a long course of treatment.

The muscles of the arm are occasionally ruptured subcutaneously, the long head of the biceps being most frequently involved.

Eight such cases have come under my observation. Only in one, in which the tendon of the biceps was completely torn through at a point in its passage through the shoulder-joint, was the injury followed by severe symptoms of functional disability. The patient in this case was a workman, forty-eight years of age, who, in breaking through a scaffolding, had clung to it with his right arm. The strength of the arm was considerably diminished; he was unable to raise it with the usual degree of force, and flexion at the elbow-joint, and more particularly supination, were much restricted. The lesion in the remaining cases was caused by falls from a height; one patient had fallen with outstretched arms into a box of lime. When I examined these patients at the end of the thirteenth week, I found comparatively few symptoms of functional disability.

If the long head of the biceps is only partly torn across, the symptoms of functional disability frequently disappear soon afterward. I have discovered partial ruptures of this kind when examining workmen for other reasons; some of the patients dimly remembered having suffered from a slight sprain years before, while others were unable to give any explanation of the lesion.

Subcutaneous ruptures of the biceps present a very

PLATE 19.

Case of Partial Rupture of the Long Head of the Biceps on the Right Side, Leading to Slight Functional Disability.

A workman, forty years of age, fell down stairs on April 30, 1898, striking on his right shoulder. He continued working, but complained of pain in the shoulder. The physician whom he consulted prescribed inunctions; subsequently he stopped work and was placed on the sick-list. I examined him on October 20, 1898. The accompanying illustration shows the two arms placed in a similar position. When the right arm is compared with the left, its outline is seen to be defective at a point corresponding to the long head of the biceps. The ball-like mass to which the muscle had contracted is better shown in the posterior view. Flexion and supination were both interfered with in the right arm. This case was not brought up for decision as to insurance allowance.

characteristic appearance; on contraction the muscle curls up into a round ball, beside which the line of rupture can be easily traced. (Compare with Plate 19.)

In addition, the following symptoms are presented: noticeable atrophy of the biceps and triceps; atrophy of the supinators of the forearm; diminished power of flexion and supination of the elbow-joint; and general weakness of the arm.

I have seen two cases of partial rupture of the short head of the biceps due to violent movements of the arm in pulling.

The triceps is sometimes ruptured by falls on the arm when the latter is flexed. Occasionally, the muscle and tendon escape and the olecranon process is torn off instead. If after complete rupture the triceps tendon is not reunited by suture, the muscle rapidly undergoes atrophy. This leads secondarily to atrophy of the flexors. The arm loses in strength; the power of extending the forearm is diminished, if not entirely suspended.

Extensive scars arising from burns, if they encircle the shoulder or elbow or are deeply attached, are likely to limit the mobility of the arm by causing abnormal tension of the skin over the joint.

Fig. 1.



Fig. 2.

Lith. Anst. F. Reichhold, München



3. Fractures of the Humerus.

Fractures of the Head of the Humerus.—

Fractures of the head of the humerus occurring as the sole lesion are a rare form of fracture. Nine such cases have, however, come under my observation. In one case the greater tuberosity was also involved, the line of fracture passing through the anatomic neck. I have also seen nine cases of fracture of the surgical neck. In almost all these cases the lesion was caused by a fall from a height (ladder, window, or stairway). One patient was thrown from a wagon; another, a hod-carrier, was injured by a hod filled with bricks falling on his outstretched arm. In another case the fracture was produced during the reduction of a dislocation of the shoulder-joint.

Fractures of the head of the humerus or of its anatomic neck usually lead to serious functional disability. Either the head of the bone is torn off at its anatomic neck by indirect violence, or the tuberosities are similarly affected; or, in case of direct fractures, the lesion is often complicated by a fracture of the coracoid process, the glenoid cavity, or the neck of the scapula. The force of the fall or blow on the shoulder that is sufficiently severe to fracture the head of the humerus is very likely to extend to the adjacent bones. Fractures of the head of the humerus are, therefore, likely to be followed by the growth of strong adhesions within the joint, which are very difficult to overcome. The condition may be relieved, to a certain degree, by early employment of massage and passive movements. As in most cases of injury, the best results are obtained in youthful patients; recovery is less and less to be hoped for the greater the age of the patient. The same is true of separation of the epiphysis accompanied by marked displacement. Even in case of uncomplicated fractures of the head of the humerus the functional power of the joint is likely to remain seriously impaired, for the simple reason that it is the joint itself that is involved.

In one case of separation of the upper epiphysis of the left humerus, in which the upper fragment was displaced backward, while the lower fragment was displaced considerably forward, the patient, a boy of six-

teen, was able, two months after the injury, to raise his arm to an angle of eighty-five degrees, although one month earlier his shoulder had been completely ankylosed.

The following symptoms of fracture of the head of the humerus are observed after recovery : the shoulder is perceptibly thickened, especially as seen from the side ; it is in some cases elevated, in others depressed, in comparison with the opposite shoulder. The groove of Molurenheim is filled out. The deformity of the head of the humerus can usually be felt through the soft parts. The arm frequently appears shortened and is sometimes held abducted, while the muscles of the shoulder, neck, and arm, and frequently also those of the forearm and hand, show signs of atrophy. Abduction is limited ; in many cases even after from three to six months of systematic treatment, counting from the date of accident, the arm can barely be raised to an angle of from sixty to seventy degrees. When extensive adhesions have formed, abduction above ninety degrees is often impossible, even a number of years later, and then is accomplished only with the cooperation of the whole shoulder and with considerable effort on the part of the patient. It is usually easier to raise the arm anteriorly. Backward movement and rotation are also restricted, and the whole extremity become weak. The long tendon of the biceps rarely escapes injury when the head of the humerus is fractured. It is also frequently involved in the adhesions that subsequently form. Consequently, contractures of the elbow-joint are often observed in these cases. The tendon is also occasionally displaced from its groove. Other sequels occur in the shape of paralysis and circulatory disorders, which may be due to direct injury of nerves and vessels or to pressure from callus.

Case of fracture of the head of the right humerus, near the anatomic neck. (Fig. 30.) Result, serious functional disability.

A man, forty-two years of age, fell about seventeen feet, on October 27, 1897. He was treated in the hospital until January 3, 1898. I examined him January 4, 1898. He was a large, strong man. The



Fig. 30.

right shoulder seemed thickened, the arm somewhat abducted, and Mohrenheim's groove filled out. The coracoid process seemed enlarged. The muscles over the chest and shoulder were atrophied. Elevation of the arm limited to 60 degrees. Crepitation was present, and the limitation of motion was marked. The patient was treated in my institute from January 5, 1898, to August 12, 1898. The insurance allowance was then fixed at 33 $\frac{1}{3}$ %. The arm could be passively elevated to 115 degrees. The patient himself could elevate it to 70 degrees, but all movement was still greatly impaired. He later received 50% insurance allowance.

Case of osteomyelitis of the head of the humerus, with extension by metastasis to the left scapula, left thigh, and right elbow-joint, following a severe contusion of the right arm and right shoulder. Sequel, recovery.

A roofer's apprentice, fifteen years of age, was injured on October 25, 1894, by the fall of some slate on his right arm and shoulder. He continued to work for two days after injury. On the third day the injured part became swollen and painful; the patient felt feverish and remained in bed. A physician was called on the fifth day and the patient was taken to the hospital. On the following day incisions were made and pus was evacuated. This operation was repeated a number of times. A fistula formed in the right arm near the deltoid, followed by the development of a second fistula above the spine of the left scapula.

I examined the patient August 17, 1895. He was a small, poorly developed boy. There were a number of scars on the right shoulder, which, together with the right arm, was greatly atrophied. A fistula still remained over the left scapula, leading toward the supraspinous fossa. The right arm could be only slightly abducted, and the right elbow-joint was ankylosed at an angle of 140 degrees. I treated the patient until March, 1896, when he was discharged with an insurance allowance of 50%. He was under treatment a number of times subsequently. At the end of 1898 he was again obliged to enter the hospital on account of the sudden appearance of abscesses in the left thigh, the right elbow-joint, and the neck, all of which were opened.

By the 13th of May, 1899, all the fistulas had closed and the scars appeared pale and superficial. The patient was able to move his right arm and right elbow-joint with ease and freedom, and could raise his arm to an angle of 175 degrees. He was able to work for ten hours daily. The development of the right arm, however was impaired; the muscles were all considerably atrophied. The strength of the right hand, nevertheless, almost equaled that of the left. Insurance allowance, 10%.

Fractures of the greater tuberosity are comparatively seldom seen; the lesion is directly caused by falls or blows, or it occurs during dislocation of the shoulder-joint or in reduction of the same. It is only in rare instances that the tuberosity is torn off.

The **symptoms** after union takes place are as follows :

the shoulder is thickened from before backward; frequently the acromion, or the tuberosity, if displaced, is distinctly prominent; the muscles of the shoulder, chest, and arm are atrophied, and movements of the arm, especially those of abduction and outward rotation, are restricted. The muscles that primarily undergo atrophy are the pectoralis major, the supraspinatus and infraspinatus, and the teres minor; the antagonists atrophy secondarily. The action of the antagonists sometimes produces a slight partial dislocation of the head of the humerus in the form of an inward rotation.

Case of fracture of the right greater tuberosity, with consequent severe functional disability.

A mason, fifty-eight years of age, fell from a ladder on April 5, 1890, striking on his left shoulder. He was under my care from June, 1890, until May, 1892. His symptoms were as follows: considerable thickening of the right shoulder, which appeared more massive than the left one; the muscles of the right shoulder, chest, and arm were much atrophied, and the arm could hardly be raised at all. The head of the humerus was distinctly rotated inward. The insurance allowance at the time of the patient's discharge was 40%, later raised by legal process to 60%. At that time his arm could barely be raised to an angle of eighty degrees.

The skiagraph, which was taken later, shows a displacement of the entire greater tuberosity, which strikes against the acromion when the arm is raised. In July, 1897, it could be raised to an angle of about 110 degrees. There has been no subsequent improvement.

In another case of fracture of the greater tuberosity occurring in a boy of fifteen, the separated tuberosity was displaced inward and upward, and could be distinctly felt under the skin. Six weeks later the arm could be raised to an angle of 145 degrees.

Fractures of the lesser tuberosity also occur very seldom as isolated lesions. The direct fractures arise from the same causes as those already enumerated for the fractures of the greater tuberosity.

The symptoms of fracture of the lesser tuberosity after union is completed are outward rotation of the humerus and, to a certain extent, of the shoulder; atrophy of the muscles of the shoulder, chest, and arm; partial dislocation of the shoulder-joint; diminished power of abduction. The arm appears thickened in the region of the axilla.

Case of separation of the lesser tuberosity due to the action of the subscapularis.

A mason, forty-nine years of age, was cleaning the ceiling with his right arm, when, in order to save himself from falling in consequence of a misstep, he caught at the wall with his hand. He immediately felt pain in the shoulder. When I examined him, I found a small, irregular, pointed tumor on the right arm rather in the anterior part of the axilla. The muscles of the right shoulder, chest, and arm were partially atrophied; the shoulder was slightly displaced backward and was somewhat shortened. Pressure on the bony tumor in the axilla caused the patient much pain, which he felt down to the ends of his fingers. On active motion the arm could be raised to an angle of 130 degrees; on passive motion, to 150 degrees.

The skiagraph showed a bony tumor situated at about the surgical neck of the right humerus, while the lesser tuberosity is absent from its normal site; the head of the humerus is somewhat displaced forward. Insurance allowance, 25%.

Treatment.—When the greater or lesser tuberosity is torn off and displaced, it may, after union, be found fixed in a position very unfavorable to the movement of the shoulder. This applies more especially to the greater tuberosity, but in either case operative measures are indicated for the relief of the condition. Operation is also to be recommended when the biceps tendon is caught in the callus after a fracture of one of the tuberosities, thereby producing ankylosis of the shoulder and at the same time a contracture of the elbow-joint.

Separation of the upper epiphysis of the humerus occurs quite frequently up to the twentieth year; less frequently between the twentieth and twenty-fifth year. The lesion is caused by a fall on the shoulder or outstretched arm. It is of importance chiefly for the reason that the development of the affected arm is likely to remain permanently impaired and smaller than its fellow, the muscles being smaller and weaker, and the hand being usually undersized.

United fractures of the surgical neck are often followed by functional disorders, which, although not, as a rule, of so serious a character as those incidental to fracture of the structures within the joint, are sufficiently grave and persistent.

The symptoms are as follows: the humerus is usually shortened, the shoulder is thickened, and the groove of Mohrenheim is filled out. If the shaft of the bone is displaced inward and the head is displaced outward, the former will, at the same time, be found abducted. The long tendon of the biceps is usually more or less injured and displaced. As the brachial plexus lies in the immediate vicinity of the seat of fracture, paralyzes due to its involvement are not infrequent. Whether paralyzed or not, all the muscles of the shoulder and arm undergo atrophy, the muscles of the forearm being also affected to a certain extent. The shoulder appears slightly elevated or depressed, according to the position of the upper fragment after consolidation. The shaft of the humerus is usually rotated inward by the pectoralis major. Abduction is almost always restricted; in some cases, however, this movement, in the course of time, can be fairly well executed. If both arms are raised together as nearly to the horizontal as the condition of the affected shoulder will permit, the thumbs pointing upward, the shoulder on the injured side invariably appears higher than its fellow and at the same time shortened. The biceps in this position is seen to be directed somewhat downward, as evidenced by the position of its tendons in the axilla. Posteriorly, the olecranon looks somewhat upward. The displacement of the biceps tendon in the shoulder-joint and the rotation of the shoulder-joint, which, as a rule, is an inward rotation, necessarily have an influence on the position of the elbow-joint; this is usually slightly pronated, in rare instances supinated, and is quite frequently fixed in an abnormal position by contractures. Complete ankylosis may result from excessive growth of callus, especially when the line of fracture is irregular and extends into the joint.

Case of compound fracture of the right humerus near the shoulder-joint, followed by recovery with marked deformity and functional disability.

A workman, forty-seven years of age, on August 5, 1895, fell from

a height of one and one-half stories into a cellar. He sustained several wounds of the face in addition to the fracture previously mentioned. He wore a splint for four weeks, and was then treated by massage. The patient was in my care from October 18, 1895, until the following August.

The left shoulder appeared greatly thickened and was exceedingly prominent on its outer aspect. The muscles of the whole left arm were atrophied. The left humerus was shortened by $4\frac{1}{2}$ cm., and could not be raised quite to a level with the shoulder, since the bone came in contact with the acromion before it reached that height. When discharged, in August, 1896, the patient was able to raise his arm to an angle of 135 degrees. He was allowed $33\frac{1}{3}\%$ insurance, reduced October 17th to 20%, since at that date he could raise the arm to an angle of about 150 degrees.

Fractures of the upper third or upper half of the humerus are liable to lead to functional disability, in spite of successful union. The shortening that results when the fragments heal at more or less of an angle is of inferior functional importance than the ankylosis of the shoulder-joint, which may persist for a long time, or may even become permanent. When the angle formed by the fragments after healing opens inward (position of varus), the head of the humerus is found to lie lower than normal in the glenoid cavity. This limits the range of motion of the shoulder-joint and interferes with the full degree of action of the deltoid. The displacement of the head of the humerus in the glenoid cavity, which can be recognized even when the joint is at rest, causes a corresponding change of position in the scapula, limiting its rotation when the arm is raised above the level of the shoulder. Abduction is further restricted by the humerus necessarily coming in contact with the acromion earlier than normal.

The effect of an angular union must, of course, be manifested in the lower fragment also, and secondarily in the elbow-joint, contractures of which are frequently observed in these cases. Angular union is most likely to take place when the line of fracture lies below the insertion of the deltoid, in which case the latter takes considerable part in the displacement.

Fractures in the middle and in the lower half of the humerus are likely to involve the musculospiral nerve, which may be torn at the time of injury or may be caught in the callus later on. Unless the nerve is sutured or freed from the callus, the paralysis becomes permanent, and the usefulness of the arm, and more especially of the hand, is seriously impaired. Of the fractures of the humerus in its lower third, those due to overflexion and overextension of the elbow-joint call for special mention. In case of the former variety we must bear in mind that the brachialis anticus and the triceps are both likely to be pierced by the fragments, while in case of the latter variety it is usually the brachialis anticus alone that is directly injured. Even when successfully reduced and treated by extension, the fracture is, in both instances, regularly followed by more or less ankylosis of the elbow-joint, requiring a course of mechanical treatment. If the fracture is especially severe or is imperfectly reduced, it is likely to lead to complete ankylosis of the elbow-joint, or at least to contractures of the same by which it is held in an abnormal position.

Weeks or months may pass before the functional disorders are overcome and the arm regains sufficient strength to permit the patient to resume work. It may be considered as an axiom that the nearer the fracture lies to the elbow-joint, the greater is the danger of ankylosis and of loss of the functional power of the arm.

Fractures of the lower end of the humerus are also fraught with danger to the nerves at that point, the musculospiral and median nerves being more frequently involved than the ulnar nerve. They may be partly or completely torn across, with corresponding degrees of paralysis of the parts supplied. Complete rupture of one of these important nerves permanently and very greatly impairs the functional power and usefulness of the arm. The same grave consequences follow when the nerve is caught in and compressed by the callus.

The following symptoms are characteristic of fractures of the lower end of the shaft of the humerus after union has taken place: the humerus is shortened; the arm is at first swollen at the point of fracture; later, there is a callous thickening of the same; the fragments may be displaced forward or backward or to the side, resulting in a cubitus valgus (X-position) or a cubitus varus (O-position); or they may be rotated in opposite directions. The forearm is fixed at an angle with the humerus (ankylosis or contractures), causing loss or impairment of the functional power of the elbow-joint, and to a certain extent of the shoulder-joint; the wrist is secondarily displaced; the muscles of the arm and forearm, and, in cases of paralysis, those of the hand also, are atrophied and weakened.

The chief aim of treatment is to overcome the ankylosis of the joints, and to this end the muscular atrophy should be treated by massage and electricity.

Case of fracture of the upper half of the left humerus, involving a direct lesion of the musculospiral nerve, followed by severe paralysis of the latter.

A hod-carrier, thirty-four years of age, was injured on October 23, 1888, by some boards falling on his outstretched arm. The boards fell from a height of four stories. He was treated in the hospital until February 22, 1889, when he was discharged unimproved. I examined him on March 13, 1889, and began treatment by massage and various exercises of the arm. In August I began to employ electricity; the reaction of degeneration was present. In the beginning of December, 1889, extension of the arm was induced by means of the faradic current; otherwise the left arm was entirely useless, being ankylosed at both the shoulder-joint and elbow-joint. It was, in addition, somewhat shortened, and showed a marked growth of callus along the line of fracture in the upper third of the bone; the whole arm was extremely atrophied. Improvement took place gradually, but only to a limited degree. The wrist and the fingers could be extended only with difficulty, and the arm was weak. In December, 1892, the patient was allowed 50% insurance, reduced in December, 1897, to 40%, at which rate it has continued.

Case of compound fracture of the left humerus, complicated by fracture of the coracoid process and several ribs. (The lesion in the latter case was overlooked.) The head of the radius subsequently became slightly displaced. (Fig. 31.)

A polisher, sixty years of age, was knocked down by a wooden beam, which struck him on the left humerus; in falling he struck on the left



Fig. 31.

shoulder. He was treated in the hospital from December 10, 1896, until March 11, 1897. The injured part was twice placed in a plaster cast, each cast remaining in position for two weeks; massage was then begun. I examined him on June 2, 1897.

The skiagraph shows the lateral displacement of both fragments and the depression in the muscles at this point. In addition, there is a slight rotation of the entire lower fragment, including the trochlear surface; also a consequent slight partial dislocation of the head of the radius and an angular position of the elbow-joint. The forearm could be extended only to an angle of 100 degrees; on active motion the arm could be raised to 45 degrees, and on passive motion to 70 degrees. The right coracoid process was thickened. The patient complained of some pain in the right side of the chest.

Case of fracture of the lower third of the right humerus, followed by ankylosis of the right elbow-joint with subsequent partial recovery.

A workman, thirty-eight years of age, on February 25, 1899, fell from a scaffolding six feet high, sustaining the lesion just mentioned. A temporary bandage was applied, for which a plaster cast was soon substituted. The latter was renewed two days later, and was again renewed after an interval of two weeks, when it was allowed to remain in position for another two weeks.

I first examined the patient on March 30, 1899, and he began a course of treatment at my hospital on April 7, 1899. At that time the right arm appeared distinctly shortened; the elbow was completely ankylosed at an angle of 120 degrees, and there was marked callous thickening of the humerus about a hand's-breadth above the elbow. The whole arm was swollen and the muscles were atrophied. On active motion the arm could be raised to an angle of 45 degrees; on passive motion, to an angle of 110 degrees. The wrist was freely movable. Treatment consisted in massage, gymnastic exercises, and the application of electricity. The patient was discharged on May 27, 1899, when he resumed work. At that time his right elbow-joint was held at an angle of 110 degrees and could be flexed with ease to an angle of 75 degrees, while the arm could be abducted to 170 degrees. The swelling and atrophy were decidedly less marked and the arm had gained considerably in strength. Insurance allowance, 25%.

Case of fracture of the lower third of the right humerus, with subsequent ankylosis of the elbow-joint.

A mason, thirty-three years of age, fell from a wall twenty-five feet high on April 22, 1887, sustaining the injury just mentioned. He was treated for one week in the hospital and then at his house. He came under my care on July 15, 1887, at which time his elbow-joint was completely ankylosed at an angle of 135 degrees. When discharged, on May 13, 1888, the elbow-joint could be flexed to an angle of 60 degrees, and could be extended to an angle of 175 degrees. Insurance allowance, 33½%. On October 17, 1888, examination showed further improvement, the elbow being held at an angle of 165 degrees. The allowance was, therefore, reduced to 15%. On July 27, 1894, he was declared to be completely cured, and could perform the work of a mason as well as ever.

Fractures of the lower articular extremity of the humerus belong to fractures of the elbow-joint. They occur in many different forms. They are observed with great frequency in combination-forms. In case of fractures of the internal condyle (inner oblique fracture), which is seldom seen, the broken fragment is likely to be displaced outward and downward by the action of the pronator radii teres, while it is at the same time drawn downward by the flexor carpi radialis and the flexor sublimis digitorum. Displacement is especially likely to occur after rupture of the internal lateral ligament. After union takes place there may be a more or less well-marked O-position (cubitus varus), the elbow-joint being at the same time flexed. All the muscles arising from the internal condyle undergo atrophy. The ulnar nerve is exposed to direct injury in fractures at this point.

Fractures of the internal condyle frequently occur in connection with dislocation of the forearm.

The external condyle is more frequently fractured than the internal; union usually takes place in an X-position (cubitus valgus) of the elbow-joint.

Fractures of either condyle usually leave the joint flexed and at the same time ankylosed. In case of fracture of the internal condyle the flexors are primarily affected by atrophy, while in case of fracture of the external condyle it is the extensors that are primarily affected, the antagonists in both cases becoming atrophied secondarily. Paralysis and trophoneurotic disorders may appear in consequence of injury to the nerves.

Separation of the internal epicondyle may be caused by direct violence, but is more frequently the result of indirect violence in the form of sudden and very forcible abduction of the arm, the epicondyle being torn off by the internal lateral ligament. It is not definitely decided whether or not the lesion can be produced by contraction of the pronator radii teres.

Separation of the external epicondyle is a rare lesion. Unless decidedly displaced, no permanent functional disorders are to be expected in case of separation of either epicondyle; the muscular atrophy is soon overcome.

After-treatment of fracture of the humerus is chiefly directed toward the mobilization of the ankylosed joints. Gradual loosening of the adhesions is to be preferred to forcible rupture, for the reason that the latter is apt to lead to the formation of new adhesions, if to nothing more serious. Forcible rupture is to be recommended only for the purpose of obtaining a more favorable fixed position of the joint. Recovery is best furthered by passive movements and medicomechanical exercises, in connection with massage, local baths, and electricity. If paralysis is caused by pressure on a nerve, in consequence of the growth of callus, the nerve should be freed from the latter by-operation.

The degree to which the patient is incapacitated for self-support depends on his functional disability. If he can raise his arm to an angle of about 110 degrees, 30% insurance allowance is usually sufficient when the right arm is involved, 25% when the left arm is involved. If he can raise it only to a level with his shoulder, 40% for the right arm and 30% for the left is an appropriate allowance, the allowance being estimated at a higher rate for more serious degrees of ankylosis. For recurrent dislocation: if occurring on active motion, 60% for the right arm and 50% for the left; if occurring on passive motion, 75% for the right arm and 60% for the left. Compensation for lesions of the elbow-joint will be discussed in the following chapter.

3. INJURIES AND TRAUMATIC DISEASES OF THE ELBOW-JOINT.

Considerations as to Anatomy and Function.—Movement of the elbow-joint is limited to flexion, extension, and rotation, the last being distinguished, according to its direction, as pronation (inward rotation) and supination (outward rotation).

Flexion is produced both at the joint between the humerus and the ulna, and at that between the humerus and the radius. It is chiefly executed on the inner grooved portion of the trochlear surface, which in the right arm is directed to the left, and in the left arm is directed to the right. As a result of the inclination of this surface, the forearm does not form a straight line with the arm, either when completely flexed or when completely extended. On flexion it approaches the chest; on extension it moves in the opposite direction, forming, when fully extended, an angle with the arm the base of which is directed outward.

Extension can be carried to an angle of about 180 degrees, sometimes more; it is limited by the contact of the apex of the olecranon with the olecranon fossa.

Flexion is limited by contact between the coronoid process of the ulna and the coronoid fossa, and can be carried to an angle of about 30 degrees. The forearm, therefore, has a total range of motion in flexion and extension of 150 degrees. The olecranon and coronoid fossae are separated by a very thin lamina of bone. Overflexion and overextension are prevented by the tension of the lateral ligaments of the elbow-joint.

The movements of pronation and supination are executed chiefly in the upper radio-ulnar joint, assisted, when the forearm is flexed, by the joint between the humerus and head of the radius, and, lastly, by the lower radio-ulnar joint. The range of motion in pronation and supination equals an arc of 180 degrees. During rotation the orbicular ligament, which encircles the head of the radius and is inserted into the margins of the lesser sigmoid cavity of the ulna, plays the part of a sliding plane.

The capsule of the elbow-joint is thin anteriorly, and still thinner posteriorly; but in the latter situation it is reinforced by the triceps and its tendon. Laterally, it is strengthened by the internal and external lateral ligaments. Flexion of the elbow-joint is produced by the *brachialis anticus* (supplied by the musculocutaneous nerve), assisted by the *biceps*, which also acts as a supinator of the forearm. The *brachialis anticus* arises from the internal and external surfaces of the humerus and is inserted into the coronoid process of the ulna; although it must be regarded as the chief agent of flexion, its short leverage disqualifies it for acting powerfully without assistance. The *biceps* (supplied by the musculocutaneous nerve) must, therefore, not be underrated in its capacity of flexor. The fact that at the same time it acts as a supinator is sufficiently explained by its insertion into the tuberosity of the radius and the fascia of the anterior surface of the forearm.

The elbow-joint is extended by the triceps, assisted by the *anconeus*.

Pronation is effected by the following muscles: the *pronator radii teres*, *flexor carpi radialis*, *pronator quadratus*, and *supinator longus*.

Supination is effected by the *biceps*, by the *supinator brevis*, and, to a certain extent, by the *supinator longus*.

Injuries and diseases of the elbow-joint or of adjacent structures have the effect of limiting or suspending the functional action of the

joint. Functional power is also restricted by pathologic changes in the shoulder or wrist.

In examining the elbow-joint the affected joint should first be compared with that of the opposite side; its functional action should then be tested, noting the range of the different movements with the aid of the goniometer. Palpation should next be practised, and, finally, the muscles of the arm, forearm, shoulder, and wrist should be carefully examined.

Statistics.—The 103 cases of injury of the elbow-joint upon which the following sections are based were divided as follows: 29 cases of contusions, sprains, and wounds; 7 cases of simple sprain; 24 dislocation-fractures; 12 simple dislocations; 31 fractures. The right arm was involved in 54 cases, the left in 45 cases; both arms were involved in 4 cases.

Contusions of the Elbow-joint.

Contusions due to falls give rise to extravasation of blood and to swelling, which very soon disappear unless the contusion is complicated by some more serious injury. Complications are, however, not infrequently met with in the shape of a fracture of the humerus (supracondylar fracture), the olecranon, or some other part of the elbow-joint. The ulnar nerve is sometimes directly affected by the contusion. The olecranon bursa beneath the tendon of the triceps frequently becomes the seat of an acute inflammation, which, unless carefully treated, may lead to suppuration. These various complications serve to delay to a considerable extent the progress of recovery.

Sprains of the Elbow-joint.

This lesion is produced by a fall on the hand or elbow or by violent traction. It may be simple or may be complicated by fracture; in any case, it is accompanied by partial laceration of the ligaments and capsule of the joint, the consequences of which are seen, after the swelling and inflammation have subsided, in a certain degree of looseness and insecurity of the joint, together with atrophy and weakness of the muscles. These symptoms persist for a considerable length of time.

The **symptoms** of contusions and sprains of the elbow-joint to be seen when the acute appearances have subsided

are : Contractures of the joint by which the latter is fixed at an angle ; muscular atrophy ; limitation of motion (flexion, extension, rotation) ; weakness of the muscles.

The **treatment** consists of systematic exercises and massage. The average insurance allowance varies from 0 to 20 %.

External lesions of the elbow-joint, wounds of various kinds, and burns, result in the formation of cicatrices, which sometimes become attached to the bone or to the tendon of the triceps. The contractures of the joint that follow can be relieved, if not entirely overcome, by mechanical treatment. In severe cases skin-grafting is indicated. The cicatrix, if attached to the bone, should be freed by operation. Insurance allowance, up to 20 %.

Dislocation of the Elbow-joint.

Although statistics in general show the elbow-joint to be involved in about 18 % of all cases of dislocation, the lesion is not often seen in workmen who have reached middle age or over. Dislocation of the elbow-joint is usually caused by a fall on the hand. In young persons a dislocation, if reduced in time, is soon followed by complete recovery. The lesion as it occurs in adults is apt to be accompanied by fracture, usually resulting in ankylosis, and invariably so if the dislocation remains unreduced. After firm adhesions have formed reduction can be accomplished only with great difficulty, and if bony union has taken place, it may be quite impossible. In cases in which the joint is fixed at an obtuse angle the condition of the patient is greatly improved by changing the position to one of flexion at a right angle, combined with supination.

Even when uncomplicated by fracture and successfully reduced, a dislocation of the elbow-joint can be recognized for some time by certain characteristic symptoms. The joint is more or less fixed in a position of flexion (cubitus valgus or occasionally cubitus varus), depending on the seat and extent of the tear in the joint-capsule and the

consequent amount of cicatricial tissue. The condition frequently calls for systematic treatment by massage and passive movement. At the time of dislocation the brachialis anticus is usually more or less torn at its point of insertion, while the tendon of the biceps and the bicipital fascia are subjected to strain. The tendon of the triceps is also likely to be somewhat injured. Atrophy of these muscles frequently occurs, therefore, resulting in diminished power of flexion and extension and in weakness of the arm. If, as occasionally happens, the coronoid process is torn off, the atrophy of the brachialis anticus is correspondingly marked and persistent. This lesion is most likely to be found in cases of backward dislocation. Lateral dislocation may be complicated by fracture of one of the condyles, leading to functional disorders which have already been discussed under fractures of the humerus. Backward dislocation is frequently complicated by fracture of the olecranon, leading to rapid atrophy of the triceps, and, secondarily, of its antagonists. Recovery may furthermore be delayed by injury to the blood-vessels. The ulnar nerve has occasionally been found displaced; functional power was, however, restored in the course of a few months.

The fractures of the elbow-joint that have not already received mention will be discussed under fractures of the forearm.

As already stated, unreduced dislocations of the elbow-joint invariably lead to permanent ankylosis of the latter.

The position most favorable to the usefulness of the arm in cases of complete ankylosis is that of flexion at a right angle, combined with a moderate degree of supination. With the arm in this position, although, as a rule, hampered by a slight stiffness of the shoulder-joint, the patient is able to perform numerous movements, such as carrying the hand to the mouth, putting the hand in the pocket, etc., whereas, if the forearm is fixed in pronation, the arm is practically useless.



Fig. 32.

Partial resection may yield a relatively useful member, but it is sometimes followed by shortening and ankylosis. The statements just made concerning primary ankylosis are equally applicable to postoperative ankylosis. The operation occasionally results in loose-jointedness, which is, as regards function, a most unfavorable outcome in the majority of cases. The patient should be provided with a jointed support for the elbow.

The insurance allowance is 60 % for the right arm, 50 % for the left, when completely ankylosed at an obtuse angle ; 40 % for the right, 30 % for the left, if at a right angle. The allowance for inflammation and tuberculosis of the elbow-joint is estimated as in cases of similar lesions in the shoulder-joint.

Case of dislocation of the head of the radius and reunited fracture of the coronoid process. (Fig. 32, p. 285.) Sequels, ankylosis of the elbow-joint and disorders of mobility of the shoulder-joint and wrist.

A mason, thirty-eight years of age, fell from a scaffolding on September 18, 1890, sustaining the foregoing injuries.

When I examined him on January 10, 1891, I found the left elbow-joint held at an angle of 120 degrees ; flexion was limited to an angle of 75 degrees. Active abduction carried the arm to 80 degrees ; passive abduction, to 95 degrees. The muscles were greatly atrophied. The wrist was somewhat stiff at first, but subsequently regained its mobility completely. The left arm was the seat of paresthesia.

In the accompanying skiagraph the condition of the elbow-joint is clearly shown ; the notch on the coronoid process is distinctly visible, and the head of the radius can be recognized beyond the ulna.

Case of poorly united comminuted fracture of the left elbow-joint, leading to ankylosis and loose-jointedness, with secondary ankylosis of the shoulder and wrist. (Fig. 33, p. 287.)

A carpenter, thirty-eight years of age, fell from a roof nine feet high on July 1, 1893. After being under treatment for fifteen months for a sprain of the elbow-joint, he fell down-stairs, again injuring the elbow. He was sent to me for a course of after-treatment on September 9, 1898, after having been treated by several other physicians. I found the left elbow-joint flexed at an angle of 135 degrees, the forearm being at the same time very strongly supinated. The whole left arm was greatly atrophied. The elbow-joint was in a condition of loose-jointedness and was incapable of active movement, either of flexion or extension. The shoulder-joint was completely, and the wrist-joint partly, ankylosed. No improvement has taken place up to date. Insurance allowance, 60 %.



Fig. 33.

Case of comminuted fracture of the right elbow-joint, accompanied by backward dislocation of the forearm. (Fig. 34, p. 289.)

A carpenter, twenty-two years of age, fell from a roof two stories high, on March 7, 1898, sustaining the foregoing injury. He was treated first in the hospital, subsequently at home, coming under my care on April 25, 1898. At that time the elbow-joint was completely ankylosed at an angle of 125 degrees, and was at the same time so strongly supinated that the patient could use it neither in dressing nor in feeding himself. Abduction at the shoulder-joint was limited to 75 degrees; mobility at the wrist-joint was practically normal.

The skiagraph shows the backward dislocation of the forearm, the lines of fracture on the olecranon process and trochlear surface, and the displacement of the fragments in the latter case; also the bony union with the coronoid process.

An attempt to reduce the dislocation was unsuccessful on account of the bony union which had already taken place. The position of the elbow-joint, however, was changed to nearly that of a right angle, and the degree of supination was reduced. Subsequent treatment completely restored the functional power of the right shoulder-joint.

When discharged, the patient could use his arm for dressing himself for eating and for various other purposes. Insurance allowance, 50%. At the present time he is employed at easy work for eleven hours a day.

The accompanying skiagraph shows the condition subsequent to the attempted reduction.

Case of loose-jointedness of the elbow following resection of the lower end of the humerus.

A workman, forty years of age, sustained a comminuted fracture of his right humerus on May 10, 1889, caused by the fall of a cog-wheel on his outstretched arm. He was treated in the hospital, where a resection was made of the lower end of the humerus, including the articular surface.

I examined him on August 9, 1889. His arm below the line of resection hung limply at his side; he could move neither forearm nor fingers. He was supplied with a jointed support, which held the arm at a convenient right angle and enabled him to lift light articles. Insurance allowance, 80%.

4. INJURIES AND TRAUMATIC DISEASES OF THE FOREARM.

Statistics.—The cases of injury of the forearm serving as a basis for the following sections number, in all, 261, being classified as follows: 205 cases of fracture; 31 of contusions and contusion-wounds; 14 of incised and punctured wounds; 11 of burns. The right forearm was involved in 121 cases, the left in 127 cases; both were injured in 13 cases.



Fig. 34.

PLATE 20.

Case of Rupture of Muscles and Tendons of the Forearm in a Case of Injury Due to the Caving-in of a Wall.

A hod-carrier, thirty-four years of age, while employed in tearing down a building was caught under a falling wall, on May 7, 1889. He sustained a severe compound fracture of the skull, and, in addition, his right forearm was badly crushed. He was treated in the hospital, where the ruptured tendons were sutured.

The accompanying illustration shows the scar on the anterior surface of the forearm and a muscle-hernia at the middle of the latter. The effort of the patient to close the hand is also depicted: he was unable to flex the fingers further. The muscle-hernia was most prominent with the hand in this position. The strength of the right arm was not more than half that of the left. The patient was an unusually strong and vigorous man. The insurance allowance was only 10%.

Contusion and Crushing of the Forearm.

Unless complicated by serious wounds of the skin, by lacerations of muscles, tendons, and nerves, or by fracture, contusions of the forearm usually heal without unfavorable consequences.

The forearm is, however, exposed to very grave accidents, especially among workmen in the trades and manufactures, as a result of which it may be severely crushed and permanently disabled. Accidents of this nature frequently occur during the loading and unloading of heavy beams, in overturning heavy blocks of granite, or when, in tearing down a building, a workman is caught under falling walls and debris. In the latter instance the injury is likely to be especially serious, since skin, muscles, and tendons may easily be torn by sharp edges or pointed masses.

Cases of crushing and mangling of an extremely severe type, involving muscles and tendons and accompanied by extensive burns, occur occasionally, although with relative infrequency, in steam laundries when hand and forearm are drawn in between hot rollers.



Severe case of mangling of the left hand and forearm accompanied by burns.

A working-girl, eighteen years of age, employed in a steam laundry, sustained the injuries of the hand and forearm just mentioned on December 16, 1892, the arm being drawn in between hot rollers. She was treated in the hospital until August 27, 1893, when a course of medico-mechanical treatment was begun.

I examined her on January 29, 1894. The left forearm was pronated, the wrist-joint was swollen, and the fingers, wrist-joint, and elbow-joint were ankylosed. They responded slightly to passive motion. The extensor surface of the forearm was marked by two long, wide, and adherent scars, reaching up to the elbow-joint, and the whole arm was entirely useless. The patient was discharged on March 17, 1894, with an insurance allowance of 60%.

The hand and forearm are also sometimes frightfully mangled by being caught between cog-wheels. No general statements can be made concerning the consequences of such injuries; each case must be judged for itself. For the symptoms observed in special instances the reader is referred to the illustrative cases here cited.

Wounds of the Forearm.

The greatest possible variety of wounds of the forearm is met with in workmen employed in the various trades and manufactures.

Reference has already been made to the wounds accompanying contusions.

Incised wounds are produced by pieces of glass, the splinters of which are apt to remain in the wound; also by sharp pieces of tin, by knives, saws, pieces of slate, etc.

Punctured wounds are caused by penetration of scissor-points and similar instruments.

In respect to sequels, extensive scars of the forearm are likely to limit the mobility of the elbow-joint, wrist, and fingers.

If a punctured wound happens to sever a large nerve-branch, the consequences are, of course, most serious, as I had occasion to observe in one case of paralysis of the muscles supplied by the musculospiral nerve. This nerve

had been severed by a punctured wound on the extensor surface of the right arm in its upper third.

Incised wounds running transversely across the lower third of the forearm, especially if close to the wrist, are attended by the danger of more or less serious injury to the muscles, tendons, and nerves at that point. Such wounds are produced by blows from an ax or hatchet, by cuts made by a circular saw or some other sharp machine, or by glass, slate, and the different edged materials of trade. If properly reunited by sutures, the tendons and nerves may be restored to power; it happens sometimes, however, that the tendons are not properly united at operation, or that the sutures subsequently give way, and in such cases functional power is greatly impaired. Even when the nerves are only partly severed, as can be determined on examination, the forearm recovers its full power very slowly and gradually, perhaps not until several years have elapsed.

The fact that trivial injuries may be followed by cellulitis, by which the part can be rendered almost useless, does not need further discussion here.

Burns of the Forearm.

These are of functional importance if they involve the skin over the wrist-joint or elbow-joint. As the skin of cicatricial tissue is frequently in an atrophic condition, it is likely to break open and is very sensitive to cold; areas of hyperesthesia are, moreover, not infrequently presented.

Fractures of the Forearm.

The following points may be stated in regard to the fracture of those portions of the bones of the forearm that are contained within the joint.

The olecranon may be torn off by muscular action or may be directly fractured by a fall. In either case it is drawn upward by the triceps, the displacement being frequently followed by fibrous rather than by bony union.

The triceps undergoes primary atrophy, which is followed by secondary involvement of the biceps, brachialis anticus, coracobrachialis, and the muscles of the forearm. In some cases the patient recovers the full use of the arm; in others, he is obliged to wear a jointed support for the elbow in order to work to any advantage. The fractured olecranon may become fixed by bony union in or beside the olecranon fossa, rather than at the point of fracture. After fracture of the olecranon the functional power of the arm is always impaired for the time being, and in some cases the disability is permanent. Direct fractures are likely to involve the ulnar nerve, in which case the symptoms of functional disorder are, of course, increased in severity.

Case of fracture of the right olecranon due to a fall from the balcony of a theater. Sequel, displacement of the olecranon, leaving an interval of the width of a finger between the fragments. One year after injury the patient was comparatively well able to support himself at his trade.

A mason, thirty-eight years of age, fell, as just described, on November 26, 1889, sustaining a fracture of the right olecranon. He was first treated in the hospital, then in the dispensary. I examined him February 21, 1890, and he remained in my care until December 20th, of the same year. Insurance allowance, $33\frac{1}{3}\%$. During that time the atrophy of the arm increased, while the triceps showed relative improvement. The arm could be abducted to an angle of 150 degrees; the elbow-joint was held flexed at an angle of 85 degrees. The patient was given a jointed support, by the aid of which he learned to perform most of the work of his trade. Insurance allowance since November, 1891, 25%.

Case of fracture of the left olecranon caused by falling and striking on the elbow, followed by severe functional disability.

A mason, forty-seven years of age, slipped and fell into a lime-pit on July 18, 1891. He was first treated in a dispensary, entering my care on October 19, 1891. At that time the left elbow-joint was flexed at an angle of 140 degrees; the olecranon was displaced upward by the width of a finger and was freely movable. The muscles were greatly atrophied; the patient complained of the arm being cold, and was unable to close the hand completely. Insurance allowance, 60%.

When the coronoid process is broken off at its base, union is always succeeded by ankylosis of the joint and atrophy of the brachialis anticus. If the ankylosis is com-

plete, the atrophy of the muscle becomes, of course, a matter of secondary consideration.

Fracture of the Ulna in its Upper Third, Accompanied by Upward Dislocation of the Head of the Radius.—This may be looked upon as one of the typical fractures of the forearm. As I have repeatedly had occasion to observe, when allowed to remain unreduced, this lesion presents the following characteristic signs after union is established: the elbow-joint is flexed and completely or almost completely ankylosed; the ulna is bent at an angle the concavity of which is directed outward; the head of the radius shows distinctly under the skin; and the whole forearm appears shortened. As is to be expected in all cases of ankylosis of the elbow-joint, the mobility of the shoulder-joint is secondarily impaired.

Fractures of the Shaft of the Ulna.—Fractures of the shaft are in most cases caused by direct violence, as from a fall on the inner side of the forearm. After union is established the ulna is usually found shortened and bent at an angle the concavity of which is directed inward. Cases are on record, however, in which fracture occurred during the process of lifting heavy weights or of setting them down when the forearm was flexed. A fracture occurring under such circumstances does not necessarily indicate a pathologic condition of the bone, as is shown by the following case:

Case of fracture of the right ulna caused by lifting a heavy bundle of hay.

A workman, forty-six years of age, felt a violent pain in his right forearm as he attempted to lift a heavy bundle of hay on November 4, 1897. The pain was accompanied by the sensation of having broken his arm. At first he was treated in a surgical clinic for muscular strain; subsequently, in another clinic, for a fracture of the right ulna. I took a skiagraph of the part on November 23, 1897.

The patient was a rather tall, very vigorous man; he gave a good family history, had served in the army, and had previously been in good health. He had never been injured until 1896, when, in lifting a heavy sack of corn to his back, he sustained a fracture of the left forearm.

The skiagraph showed an ununited fracture of the right ulna in its lower third; and also that the bones were developed to an unusual degree.

Fractures of the shaft are usually followed by muscular atrophy and by slight functional disability of the elbow-joint and wrist, depending on the displacement.

The fragments may be so far displaced as to come into contact with the shaft of the radius, thereby limiting movements of rotation. The same effect is produced by a like displacement of the fragments of the radius in cases of fracture of the latter bone. The insurance allowance in such cases is estimated at from $33\frac{1}{3}\%$ to 40% for the right arm, from 25% to 30% for the left, or even higher.

If both ulna and radius are involved in the fracture, the four fragments may in very rare instances become consolidated at a point of common convergence. The case cited by Helferich in his "Fractures and Dislocations" is very instructive in regard to the use of narrow splints, which are likely to cause too great a degree of compression.

Fractures of the head of the radius are often followed by considerable displacement, resulting in ankylosis of the joint.

Fractures of the shaft of the radius, usually caused by direct violence, are met with in comparatively few cases. The subsequent displacement, due to action of the biceps, increases as the line of fracture approaches the upper third of the bone.

The **prognosis** as to function in fractures of the forearm involving both bones is unfavorable if there is any considerable degree of displacement. In the majority of such cases pronation and supination are greatly limited, while flexion and extension are imperfectly executed in certain respects, interfering very decidedly with the usefulness of the arm.

The functional disability is greater the nearer the fracture lies to the joint. Fractures of both bones near the wrist-joint are likely to produce marked degrees of displacement and to be very slow in healing.

Case of fracture of the lower third of the forearm with extreme degree of displacement and severe functional disability.

A workman, thirty-six years of age, fell, striking on the left hand, in October, 1893. He sustained a fracture of the lower third of the left forearm, which in uniting left a very marked concavity on the radial side. The arm was refractured in the hospital, but the operation proved unsuccessful, the bones returning to their former position, while union took place very slowly.

I examined and took a skiagraph of the patient November 28, 1897. There was marked deformity of the forearm, which was shortened and atrophied. The hand was displaced backward, the muscles felt soft and were much atrophied; the temperature of the part was depressed. The forearm presented a concavity on the radial side. The left hand could exert but very little pressure; the elbow-joint permitted pronation and supination to a normal degree, but the mobility of the wrist was greatly restricted. The last three fingers were held slightly flexed, but could be closed. The patient was allowed 40% insurance allowance.

Case of fracture of the lower third of the left forearm. (Fig. 35.)

The accompanying figure illustrates a case analogous to the one just described.

A mason, thirty-seven years of age, fell from a scaffolding on August 31, 1893, sustaining the injury previously mentioned. He was treated in the hospital.

I examined and took a skiagraph of the patient on March 22, 1898. I found the functional power of the arm considerably diminished; the muscles of the whole arm, including the hand, were greatly atrophied. It was shortened by three centimeters and its strength was diminished by three-fourths. He was at first allowed 70% insurance allowance; it was later reduced to 40%, at which rate it has been continued up to the present time.

The unfavorable results as regard pronation and supination which are seen in cases of fracture accompanied by marked displacement of the fragments have already been mentioned. Functional power may in other cases be impaired in consequence of pseudo-arthritis and ischemic muscular paralysis.

Pseudo-arthritis causes grave functional disability. It usually renders movements demanding the exhibition of much strength out of the question, although a few instances are on record in which considerable power was displayed some time after injury. Patients are frequently obliged to wear a fixation-bandage around the forearm in order to use the hand even for ordinary purposes. The lower fragment is apt to become greatly atrophied, the



Fig. 35.

atrophy involving not only the muscles and adipose tissue, but extending in the course of time to the bone as well. In some cases union may finally be established, even when a considerable period has elapsed after injury; I have known it to occur as long as two years afterward.

The development of a new joint is seldom favorable to functional power as far as movements of rotation are concerned.

Ischemic muscular paralysis is a paralysis of the muscles of the forearm due to compression from too firm a bandage. Unless treated early, the condition is a very difficult one to overcome.

Typical Fractures of the Radius.—

My personal observation has covered 146 cases of these fractures.

In examining the radius with reference to remitted fractures it is advisable to begin by inspection, first with the arms hanging at the side, then with the thumbs of both hands placed side by side. The appearance of the extensor and flexor surfaces should be carefully noted, also the profile of the part. In practising palpation the lower fragment, the head of the ulna, the capsule of the joint, the carpal bones, etc., should be thoroughly gone over. All the joints of the arm should be tested as to their functional ability.

We are justified in using the term typical fractures of the radius in describing the fractures of the lower end of the bone, not only because of the frequency of their occurrence, but also because they almost all arise under similar circumstances and present characteristic appearances, both before and after consolidation, in spite of the great diversity of their forms. Many cases of so-called sprains of the wrist are really fractures of this type. The two lesions are, in fact, frequently produced in the same manner,—by a fall on the hand,—so that it would not seem inappropriate to speak of fractures of the kind under discussion as “sprain-fractures.”

The force of the fall which produces them is not necessarily applied to the palm of the hand; they may equally well be caused by a fall on the back of the hand or on the clenched hand. I have also known cases to occur

from overextension of the wrist when unloading heavy beams, or even as a result of a fall or blow on the lower end of the ulna. The ulna in some instances remained intact, while in others the styloid process was broken off. The line of fracture varies with the cause which produces it and the manner in which the force is applied. It is important to ascertain all the facts bearing on this point in order to gain a clear understanding of the subsequent displacement and functional disability. When the line of fracture runs transversely, as it does when the fracture is caused by a fall on the outstretched hand, the lower fragment is almost invariably displaced backward, while it is usually displaced forward in case of falls on the dorsum of the hand.

Union may be established within the first week or two, or may require three or four weeks' time. In one case a skiagraph taken three weeks after the injury occurred showed precisely the same condition as had existed on the fourth day. It does not do, therefore, to maintain a fixation-bandage for the same length of time in all cases.

The **symptoms** of typical fractures of the radius after union is established are as follows :

The wrist appears broader and thicker than normal, and the head of the ulna is considerably displaced to the side. The hand is displaced to the radial side, while the fingers often point more to the ulnar side. (This is probably often due to the bandage.) In case of backward displacement of the lower fragment the latter shows as a rounded prominence on the posterior aspect of the forearm close to the wrist ; above the prominence there is a hollow. Close to the wrist on the flexor surface of the forearm the soft parts (the pronator quadratus muscle and flexor tendons) project in the form of a soft tumor. This prominence of the soft parts of the flexor surface is a regular accompaniment of the cases caused by a fall on the palm of the hand, but is not seen in those caused by a fall on the dorsum of

the hand. The shaft of the radius is displaced, as a rule, being rotated outward by the muscles attached to the external condyle of the humerus and the external condyloid ridge. Occasionally, however, the shaft is rotated inward. In consequence of this displacement of the shaft of the radius the radius and ulna cross each other, either above or below the normal point. The displacement of the bone of course involves a similar change of position of the muscles surrounding it, as is shown by a marked depression on the radial side of the forearm in its lower third, due to the outward displacement of the point of insertion of the tendon of the supinator longus. Partial dislocations, varying in degree, are seen in both the superior and inferior radio-ulnar joints, and in case of the latter the dislocation may even be a complete one. The forearm also very frequently appears shortened. In the majority of cases the styloid process of the ulna is broken off and the capsule of the wrist-joint is swollen. The muscles of the forearm and hand show signs of atrophy, and those of the upper extremity are often similarly affected, especially the biceps. The atrophy of the biceps—which is due to the displacement of the shaft of the radius and the restriction of supination—diminishes its power as a flexor of the elbow-joint. The elbow-joint is apt to be held flexed at first, allowing neither complete flexion nor complete extension. Abduction of the arm is also likely to be somewhat restricted. In some cases there is paralysis of the parts supplied by the musculospiral, median, or ulnar nerves.

The bones of the carpus usually escape injury; if not, the scaphoid is the one most likely to be involved. The lesion usually takes the form of a fracture; occasionally, however, the scaphoid is dislocated or is driven into the cancellous tissue of the radius.

The relation between the articular surface of the radius and the carpus is, on the other hand, never normal in these cases, and the ligaments of the carpus are always stretched and loosened. This results in imperfect closure



Fig. 36.

and weakness of the hand, which are noticeable symptoms of the recent injury, and sometimes persist for a long time.

The range of motion at the wrist is considerably diminished, and pronation and supination are restricted in almost all cases.

The **treatment** of the foregoing condition consists of massage and passive motion and of gymnastic exercises for the purpose of overcoming the displacement and ankylosis. Traction made with increasing weights and rotatory movements are very beneficial, while electricity should be employed for the paralysis.

As far as duration of treatment is concerned, the parts may within a few weeks regain as much functional power as can be hoped for at all, or the course of exercises, etc., may need to be kept up for months, or even for one or two years.

Incapacity for self-support, which is proportionate to functional disability, varies from 10 %, 15 %, or 20 % in light cases, to 50 %, 60 %, or even 70 % in serious ones. To the latter class belong the cases of loose-jointedness due to extensive laceration of the capsule of the wrist-joint.

As already stated, dislocation or subluxation of the inferior radio-ulnar joint is a very frequent complication of typical fractures of the radius.

The styloid process of the ulna is occasionally rotated so as to be directed forward or backward, and the whole lower end of the ulna may be found abnormally movable.

Case of reunited typical fracture of the radius followed by perfect recovery. (Fig. 36, p. 301.)

The subject of the accompanying skiagraph was a workman, forty years of age, who, when pushing a handcart, on August 27, 1898, struck against a heap of stones, causing his hand to be violently pressed backward. He was at first treated for a sprain of the wrist.

The skiagraph shows the fracture of the radial epiphysis, completely reunited, the line of fracture showing but very little. The styloid process of the ulna is seen to be broken off, and the ulna is slightly displaced forward, striking against the semilunar bone. The scaphoid is evidently not in normal position.



Fig. 37.

At the time I examined the patient, on September 6, 1898, the movements of the wrist-joint were considerably limited, and the fingers could not be completely closed.

Indemnity was not required in this case, as the patient made a complete recovery before the beginning of the fourteenth week, the time when insurance is first paid.

Case of typical fracture of the left radius (Fig. 37, p. 303), resulting in partial recovery.

A carpenter, forty-eight years of age, fell from a roof, on November 15, 1897, landing on a heap of sand, with his left hand extended.

I examined and took a skiagraph of the patient on November 25, 1897. The fracture is shown in the accompanying illustration. The forearm, wrist, and fingers were greatly swollen; the fingers could not be closed, and the deformity was extremely well marked. The injured part was placed in temporary plaster bandages, and was treated also by massage, steam baths, and later on by exercises. The deformity was overcome by refracture of the bone.

The patient was discharged on May 21, 1898, with an insurance allowance of 30%.

The index-finger and middle finger had been mutilated in an earlier accident; otherwise the hand could be completely closed; the grip, however, was still weak. Six months later the insurance allowance was reduced to 20%, at which rate it has continued.

Case of typical fracture of the radius, accompanied by dislocation of the inferior radio-ulnar joint.

A workman, thirty-one years of age, fell from a ladder on August 26, 1898. (Fig. 38, p. 305.)

The skiagraph taken on October 10, 1898, showed union to have taken place. The wrist, however, was still swollen, and its mobility was restricted. The patient was still unable to close the hand, which was very weak. The head of the ulna was very freely movable.

The skiagraph shows the line of fracture in the radial epiphysis, the dislocation of the inferior radio-ulnar joint, the displacement of the bones of the carpus, and the displacement of the hand to the radial side. When discharged, after considerable improvement had taken place, the patient was conceded an insurance allowance of 30%.

5. INJURIES AND TRAUMATIC DISEASES OF THE WRIST-JOINT.

Considerations as to Anatomy and Function.—The mechanism of the wrist is rather complicated, normally consisting of six separate joints or combination joints.

1. The radiocarpal articulation,—the wrist-joint proper,—formed by the radius above and the scaphoid and semilunar bones below. Flexion and extension take place in this joint.

2. The inferior radio-ulnar articulation, permitting of the movements of pronation and supination, constituting the rotation of the wrist.

3. The joint between the pisiform and cuneiform bones.



Fig. 38.

4. The combination joint between the scaphoid, semilunar, cuneiform, unciform, os magnum, trapezoid, inner surface of the trapezium, and the bases of the second and third metacarpal bones, forming the intercarpal and metacarpal joints.

5. The articulation between the unciform bone and the bases of the fourth and fifth metacarpal bones.

6. The articulation between the trapezium and first metacarpal bone.

The last-named joint (reciprocal reception) is always entirely separate from the others, while in some individuals all the other five joints may be in communication with one another. In such cases we have to deal with two joints, or rather with one joint and one combination joint. The communication existing between these five joints explains the rapid involvement of the whole wrist in some cases of infection. A similar extension of infection to the wrist in cases of injury of the joint between the trapezium and first metacarpal bone is to be explained by the destruction of the interosseous ligament. In operating for the removal of the thumb and first metacarpal bone, injury of this ligament should be carefully avoided. This can best be accomplished by entering the joint immediately below the insertion of the tendon of the abductor longus pollicis (extensor secundi internodii pollicis).

The fact that the triangular fibrocartilage occasionally presents a perforation is of importance in dealing with injuries and diseases of the lower radio-ulnar joint.

Another point to be borne in mind is the occasional existence of interosseous ligaments between the joints which usually intercommunicate, thus increasing the number of separate joints in the wrist.

The strongest ligament of the wrist-joint is found on its anterior surface; posteriorly, the ligament consists of separate and comparatively weak fibrous bands connecting adjacent bones. When the wrist-joint becomes filled with a fluid exudate, the capsule of the joint is pressed out between these bands, forming the so-called ganglia of the wrist.

In their passage across the back of the wrist the extensor tendons are retained in position by the posterior annular ligament, an extension of the posterior fascia of the forearm. It is strengthened by some additional fibers. It is divided, as a rule, into seven separate compartments for the various tendons, some of which are usually inclosed in a common synovial membrane.

The wrist is capable of the following movements:

1. Flexion (anteflexion).
2. Extension (retroflexion).
3. Abduction (movement toward the radial side, radial flexion).
4. Adduction (movement toward the ulnar side, ulnar flexion).
5. Circumduction, which is a combination of the four previous movements.

6. Rotation (pronation and supination) in the inferior radio-ulnar joint.

Flexion, extension, abduction, and adduction are executed in the wrist-joint proper—the radiocarpal articulation. Flexion and extension are limited—in addition to the tension of the ligaments—by the

contact, above or below, between the radius on the one hand and the scaphoid and semilunar on the other.

Flexion and extension take place around a transverse axis with very little change of plane. The angle to which these movements can be carried varies greatly in different individuals, and even varies as to the two hands in the same individual. According to the measurements that I have taken on individuals of different ages and in various classes of society, extension is, as a rule, somewhat more limited than flexion; this point, however, often depends upon the profession of the individual. In a number of roofers who were expert in climbing I found the angle of extension to exceed that of flexion. The average angle of extension was 60 degrees, carried in special cases to from 85 to 90 degrees; the average angle of flexion was 65½ degrees; its extreme limit, 90 degrees.

In extreme flexion and extension the wrist-joint proper is assisted by the joints between the two rows of carpal bones.

The axis around which the carpus revolves in abduction and adduction does not form a straight line, but, on the contrary, the plane of motion almost constantly changes. The angle of abduction never equals that of adduction, the former, according to my measurements, being represented, on the average, by 32½ degrees, the latter by nearly 50 degrees. The change in the plane of motion increases as the extremes of abduction and adduction are reached, especially in the case of adduction. A certain degree of movement occurs at the same time among the joints between the carpal bones, the scaphoid taking part in adduction, the cuneiform in abduction. It is not possible, however, to enter into a discussion of these points here.

Pronation and supination are executed in the superior and inferior radio-ulnar articulations. Although limited by the tension of ligaments and tendons, the angle thus obtained may equal or exceed 180 degrees. The radius during this movement rotates around the ulna. Duchenne maintains that the ulna moves simultaneously.

Mobility of the wrist is essential to workers employed in the various branches of industry, especially to those whose work requires them either to grasp and to hold heavy articles, while directing their further progress with the wrist-joint, or to exert pressure on the hand. Ankylosis of the wrist-joint following fractures, dislocations, sprains, and inflammatory processes causes a corresponding degree of disability for self-support on the part of the patient.

Statistics.—In addition to the 146 cases of typical fracture of the radius, my material includes 87 cases of injury of the wrist-joint, observed after healing took place. This number includes 11 cases of injuries due to contusion, 51 cases of sprain, 5 of dislocation of the bones of the carpus, 14 of fracture of the bones of the carpus or of the styloid process of the ulna occurring separately, and 6 of wounds.

Sprains of the Wrist-joint.

Sprains of the wrist-joint are a very common form of injury. If in describing an injury of the wrist-joint we

apply the term sprain strictly in the sense of its definition in the first part of this book,—namely, as a dislocation of only momentary duration, righting itself at once,—we shall be obliged to exclude a number of other injuries of similar etiology which are often covered by the name of sprain. Under “sprains” we find typical fractures of the radius, fractures and dislocations of the bones of the carpus, dislocations of the inferior radio-ulnar articulation, etc.

True sprains, in which the lesion consists only of a strain or slight laceration of the capsule and ligaments of the joint, are soon cured by rest of the part, together with compresses and massage, although frequently the joint remains weak and the capsule continues relaxed for some time.

In almost all cases of sprain coming under my observation for the last three years I have, by the aid of skiagraphs, discovered a dislocation of the inferior radio-ulnar joint.

Dislocation of the Radio-ulnar Joint.

This lesion, which is not at all uncommon, is usually caused by falling on the hand or by twisting the wrist in lifting or setting down heavy burdens. It is also frequently seen as an accompaniment of typical fractures of the radius.

When the acute swelling and inflammation have subsided, leaving the joint-capsule somewhat thickened, the wrist appears broader than normal, or, to speak more accurately, the transverse diameter of the lower extremities of the radius and ulna is increased. The head of the ulna is usually more movable than that of the normal wrist; the strength of the hand is diminished, and the patient is conscious of weakness of the wrist-joint, which is somewhat relieved by wearing a bandage around it. Movement of the wrist is in most cases painful rather than restricted. Pronation and supination are usually well

preserved, but are apt to cause pain. The muscles of the forearm are but slightly affected, though those on the ulnar side may show signs of atrophy. By the aid of a skiagraph we can demonstrate the complete dislocation of the inferior radio-ulnar joint, and in a number of cases we also find that the head of the ulna is rotated so that the styloid process points directly forward or backward. Sometimes the head of the ulna is displaced upward or downward, indicating, of course, more or less laceration of the inferior radio-ulnar ligaments. This leads to a secondary displacement of the elbow-joint, which is usually, however, of slight importance, and is not marked by functional disability. The average insurance allowance is 20 %.

Dislocation of the Wrist-joint.

Simple dislocations of the wrist-joint are rare. The so-called dislocation usually includes a fracture of the radius. The latter is accompanied by displacement of the lower fragment, together with the whole hand; the wrist-joint, however, remains partly dislocated. A similar subluxation is also frequently to be seen as a result of a sprain. In cases of backward dislocation of the wrist-joint, which are usually caused by the overextension incidental to a fall on the hand, the hand is held flexed; the bones of the carpus—the scaphoid, semilunar, and cuneiform—are distinctly prominent; movement of the wrist-joint is suspended, and the hand can not be closed. In cases of forward dislocation due to a fall on the dorsum of the hand when the wrist is flexed, the lower extremities of the bones of the forearm project distinctly, the hand is flexed and hangs limp, and the mobility of the wrist is almost completely lost.

The foregoing characteristic symptoms persist until the dislocation is reduced, which in a neglected case may prove a difficult or impossible procedure. If the patient is young and reduction is at once practised, complete recovery

may be expected. In a case occurring in a pupil in a gymnasium who was practising on a horizontal bar, immediate reduction was followed by a permanently good result.

It is worthy of mention that subluxation of the wrist is seen occasionally as a result of special work in individuals employed in certain branches of industry. Madelung describes a case of this kind in which the lesion was attributed to the strain incidental to the work of his trade. (Cited by Thiem.)

Dislocation of the Bones of the Carpus.

A dislocation between the two rows of the carpal bones has been observed in rare instances, the usual cause being a fall on the hand. Dislocation of one of the carpal bones alone occurs somewhat less infrequently. The dislocation may be the only lesion present, or it may occur in connection with other lesions, such as fractures of the radius or sprains of the wrist-joint; it may, furthermore, be partial or complete.

Partial dislocations are caused by the violent contact between the bones incidental to a fall on the hand or by traction in endeavoring to free the hand when it is caught and held fast. The ligaments connecting the carpal bones are more or less torn at the time of injury; they become lax in consequence, and allow the carpal bones to become displaced. The bones are most likely to be displaced backward, owing to the weakness of the posterior ligaments. In most cases it is the os magnum which is involved, and which can be seen and felt projecting backward.

Partial dislocations of the carpal bones are frequently seen subsequent to fractures of the radius, and are to be explained, as a rule, by the strain and subsequent laxness of the ligaments. When some time has elapsed after injury, the displaced carpal bone can easily be mistaken

for a ganglion ; the diagnosis is, however, made clear by a careful examination.

In cases of complete dislocation the scaphoid is the bone most frequently involved. In a case occurring in connection with a fracture of the radius due to a fall on the hand I found the scaphoid impacted in the substance of the radius. (See Plate 36.)

I have seen three cases of backward subluxation of the os magnum. Apart from the tumor-like projection on the dorsum of the hand, the only symptom of the lesion was a temporary weakness of the hand.

One case of forward dislocation of the trapezium has come under my observation. The ball of the thumb appeared swollen and thickened ; the thumb was somewhat displaced forward and its mobility was restricted. For about four months the patient was unable to use the hand for grasping and similar movements.

I have had two cases of dislocation of the pisiform bone occurring as the sole lesion, both of which were caused by a fall on the hand. Both cases had been diagnosed as sprains of the wrist. The pisiform bone was displaced above the transverse fold which runs across the anterior surface of the wrist close to the palm of the hand. In one of these cases four months had elapsed since the lesion occurred, and reduction was not indicated. The flexor carpi ulnaris and the ball of the little finger were atrophied, and adduction of the wrist was limited ; there was also a slight loss of strength. All the symptoms completely disappeared within three months. The second case concerned a workman whom I examined six weeks after the injury, and who made a rapid recovery.

In respect to the rate of insurance allowance, the reader is referred to the illustrative cases.

Lembke, in the "*Archiv für Unfallheilkunde*," volume III, describes an outward dislocation of the scaphoid bone. Its concave surface lay against the apex of the styloid process of the radius, to which it had become united, while its convex surface was directed

outward. The trapezium and trapezoid were thereby displaced forward, together with the first two metacarpal bones and fingers. The semilunar, cuneiform, os magnum, and unciform were all fractured. Extension of the wrist-joint could be carried to an angle of fifteen degrees, but flexion was altogether suspended. Abduction and adduction were reduced by one-half; the thumb was limited as to flexion; otherwise the movements of the fingers were normal. The cause of injury in this case was direct violence.

Lembke also described a case of backward dislocation of the semilunar which likewise accompanied a fracture of the radius. The case was also complicated by fracture of the os magnum and the unciform.

Dislocations of the carpometacarpal joints are also extremely rare lesions, with the exception of the first carpometacarpal joint, in which dislocation occurs com-

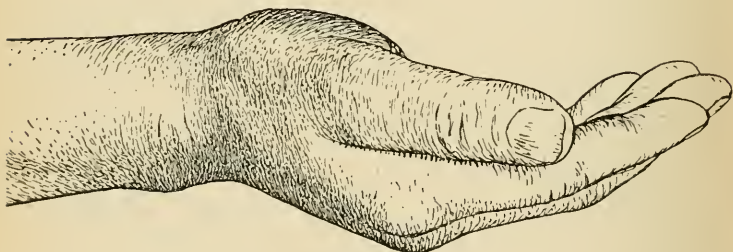


Fig. 39.

paratively often. I am indebted to G. Schütz for two cases of dislocation of from the second to the fifth and from the first to the fourth metacarpal bones, respectively. In both instances the lesion was caused by an accident with a steam-press.

In these cases the metacarpal bone is invariably displaced backward, and the appearance of the hand is very characteristic. The base of the metacarpal bones project distinctly, and the movements of the wrist-joint, especially flexion and extension, are greatly restricted. The fingers can not be closed at all, and their power of extension is restricted.

Case of forward dislocation of the first metacarpal bone at the metacarpophalangeal joint.

A mason, twenty-two years of age, accidentally struck his right hand with a hammer. The lesion was diagnosed as a fracture of the thumb. When I examined the patient, on October 15, 1898, I found the ball of the thumb swollen and painful; the fingers were held flexed, and the thumb could be only slightly moved. A skiagraph showed a forward dislocation of the head of the first metacarpal bone.

The course of treatment was interrupted a few weeks later by the arrest and imprisonment of the patient. The accompanying illustration shows the appearance of the hand, including the thickening of the ball of the thumb.

Case of a sprain of the wrist-joint accompanied by dislocation of the pisiform bone.

A workman, forty-nine years of age, fell into a ditch on May 23, 1896. Among other injuries he sustained a sprain of the right wrist. The skiagraph showed a typical dislocation of the inferior radio-ulnar joint and upward dislocation of the pisiform bone. The head of the ulna was very freely movable; the forearm, especially on its ulnar aspect, was decidedly atrophied, as were also the ball of the little finger and, in part, the ball of the thumb. The hand had lost considerably in strength. Insurance allowance, 20%.

Case of dislocation of the pisiform bone, due to a fall on the hand.

A mason, forty-four years of age, fell from a scaffolding nine feet high on June 24, 1892. He was treated for some time for a sprain of the wrist. When I examined him, on November 30, 1892, I found the pisiform bone displaced upward above the transverse fold of the wrist. The symptoms in this case were exactly similar to those of the preceding one. Insurance allowance at first, 20% ; six months later, complete recovery.

Case of subluxation of the os magnum caused by a blow from a marble slab which fell upon the hand.

A stone-mason, forty-five years of age, was trying to support a marble slab with both hands when it slipped and fell on his right hand, holding it fast. He involuntarily made an effort to extricate the hand. The accident happened on March 9, 1899. When I examined him, on March 22d, I found the wrist moderately swollen and distinctly thickened at one point posteriorly. The skiagraph that was taken showed that the carpal bones were placed somewhat unusually far apart. Extension was somewhat diminished and the hand had slightly lost in strength. No insurance allowance.

Fractures of the Bones of the Carpus.

The carpal bones may be fractured by direct violence, as when the wrist is crushed under falling objects or mangled between cog-wheels, or by indirect violence, such as a fall on the hand. Fractures of the carpal bones not infrequently accompany fractures of the radius.

PLATE 21.

Case of Scar-keloid on the Dorsum of the Left Hand.

A mason's apprentice, fifteen years of age, was burned on the left side of the face and on both hands by an explosion of gas. Healing was followed by keloid growth in the scars on both face and hands, especially marked in the case of the left hand.

The colored plate shows the scars on the lower part of the forearm extending down to the midphalangeal joints of from the second to the fifth fingers inclusive, limiting both the flexion and extension of the wrist, as is distinctly to be seen in the accompanying illustrations. (Figs. 40 and 41.) The patient could close the hand, but was unable to hold anything. Figure 40 shows the extension of the hand, which was limited to an angle of about thirty-five degrees; in this position the scar-tissue was thrown into folds between the back of the hand and the forearm. In figure 41 the hand is flexed, thereby stretching the scar. Flexion was limited to an angle of twenty degrees. Insurance allowance, 20 %.

The bones of the carpus are not exposed to extensive degrees of displacement, but the effect on functional power of even a slight displacement which only a practised eye can recognize is not to be underestimated. Trifling changes of relation between the bones of the carpus have an influence on the position of the metacarpal bones, and are manifested also in certain limitations in the movements of the fingers. There may be, furthermore, a slight subluxation of the radiocarpal joint. Occasionally, the metacarpal bones are involved in the fracture to the extent of being notched at their bases; they may also be displaced forward or backward, and in rare instances may be rotated on their long axes. Displacement of a metacarpal bone causes temporarily a certain awkwardness of movement in the corresponding finger.

In case of fracture of the bones of the carpus without displacement, functional power is only temporarily impaired, unless the injury is a severe one involving several bones, as when the wrist is crushed or mangled. In the latter case the wrist remains permanently and completely ankylosed. The symptoms which I had the opportunity to observe in two cases of fracture of the trapezoid were



restricted movement of the thumb, sensitiveness of the ball of the thumb to pressure, moderate swelling of the first carpometacarpal joint, and inability on the part of the patient to grasp an article with any power or to maintain his hold on it.

Case of ununited fracture of the scaphoid.

A workman, thirty-four years of age, stumbled over a beam and fell on his right hand on January 18, 1896. He was treated for a sprain. Six months later the same hand was caught under a beam, crushing the wrist. A skiagraph that was taken about eighteen months later showed an ununited fracture of the scaphoid. The wrist has remained swollen posteriorly, and still crepitates distinctly on movement; the affected part is considerably weakened. The patient wears a bandage around his wrist. Insurance allowance, 20%.

Injuries of the nerves and infectious processes constitute the most serious complications of fractures and dislocations of the carpal bones, leading, especially in case of infection, to grave functional disability of the wrist, frequently of a permanent nature.

Simple fractures of the carpus, when properly treated, usually unite rapidly and satisfactorily. If in consequence of a mistaken diagnosis the patient is permitted to resume work too soon, the prognosis as to functional power may be unfavorably affected.

Serious cases of fracture, especially when involving several bones, invariably lead to ankylosis.

Ankylosis of the wrist not only affects the mobility of that joint, but also prevents the fingers from closing normally.

Insurance allowance, 40% for the right hand, 30% for the left. It is only in exceptional cases that ankylosis of the wrist can fail to incapacitate the patient more or less for the duties of his trade. A case of this kind is described under plate 23.

Scars on the Wrist.

If the mobility of the wrist is affected by a scar, the working capacity of the patient is likely to be diminished to a degree corresponding with the loss of functional

power. The further the scar extends across the wrist and down the hand toward the fingers, either on the palm or back of the hand, the more serious, as a rule, is its influence



Fig. 40.



Fig. 41.

on mobility. A scar-keloid, for instance, extending over the wrist may seriously disable the latter, although in itself it is a perfectly healthy joint. Scars adherent to the

underlying tissues, especially if deeply attached, bring about the worst results.

Chronic tenosynovitis is quite frequently observed at the wrist, giving rise to tenalgia crepitans, of which crackling sounds on movement of the wrist, sometimes accompanied by pain, are among the characteristic symptoms.

Chronic tenosynovitis occurs also as a professional disease in various branches of industry, being met with in turners, cabinet-makers, locksmiths, blacksmiths, etc.

6. INJURIES AND TRAUMATIC DISEASES OF THE HAND AND FINGERS.

Function of the Metacarpal Bones and Fingers.—The five metacarpal bones, which form the framework of the hand proper, are somewhat concave anteriorly, slightly convex posteriorly.

The hand presents two surfaces—an anterior, called the palm, and a posterior, called the dorsum or back of the hand.

The first metacarpal bone, supporting the ball of the thumb, displays a comparatively wide range of motion, the mobility of the other four metacarpal bones being extremely limited. Of the latter, the fifth is somewhat more movable than the others, while the third is practically immovable. In respect to their mobility, the fingers present a marked contrast to the corresponding metacarpal bones.

The phalanges are distinguished as the first or proximal phalanx, the second or midphalanx, and the third or distal phalanx, while the joints of the fingers are known as the metacarpophalangeal, midphalangeal, and distal phalangeal joints, respectively.

The metacarpophalangeal joints are of the condyloid variety, allowing of the following movements:

1. Flexion, which can be carried to an angle of 90 degrees; slightly higher in the case of the little finger.

2. Extension. This movement is very limited. On active motion the thumb can be extended to an angle of about 50 degrees; the index-finger to about 30 degrees, the middle finger to about 25 degrees, while in case of the fourth and fifth fingers there is no power of extension worth mentioning.

3. Lateral movement, abduction, adduction (limited), and spreading apart.

4. Rotation (on passive motion).

The chief agents of flexion are the long flexors of the fingers, the tendons of which are inserted in the second and third phalanges; the interossei which are attached to the first phalanges acting as a pulley, drawing them toward the middle line when the hand is to be closed, and pulling them apart when it is opened.

The capsules of the metacarpophalangeal joints are very thin pos-

teriorly, and are protected from being caught between the bones and from the injurious effects of too great atmospheric pressure by the extensor tendons, which form the dorsal aponeurosis and are attached to the capsule over the joints. Laterally, the capsules are reinforced by the lateral ligaments, which are put on the stretch when the fingers are flexed, and which greatly restrict lateral movement of the fingers.

The movements of the fingers, especially of the fourth finger, are further restricted by the tendinous slips connecting the extensor tendon of the fourth finger with those of the middle and little fingers, respectively. On the posterior aspect of the wrist-joint the synovial sheath of the extensor longus pollicis is frequently found to connect with those of the extensor carpi radialis longior and brevior, which also in many cases communicate with each other. Opposite the metacarpophalangeal joints the tendons of the extensor muscles of the fingers unite with those of the lumbricales and interossei proceeding from the radial and ulnar sides of the hand, to form a broad aponeurosis, which covers the phalanges posteriorly and is attached to the capsules of the metacarpophalangeal joints. As it passes along the posterior surface of each proximal phalanx, to which it is not attached, the extensor tendon, which forms its central portion, divides into three slips; the middle slip is inserted at the midphalangeal joint, while the two lateral slips, in connection with the tendons of the lumbricales and interossei, pass further down the finger, to be inserted into the distal phalangeal joint. Thus, the dorsal aponeurosis is attached to all three phalangeal joints. On the palmar side there is a communication between the synovial sheaths of the tendons of the thumb and little finger, as is demonstrated by the rapid spread of infection from one tendon to the other when either is involved. [These tendons are usually stated to communicate through the general sheath to which they extend.—Ed.]

The palm of the hand provides a receptacle for the objects that are seized and held by the fingers, or, rather, by the fingers and metacarpal bones on one side and the thumb on the other, like a pair of tongs. The ball of the thumb and that of the little finger also act as opposing forces in the process of grasping an object with the hand.

Normally, when the hand is completely closed in a fist, the fingers are turned under in the palm of the hand; if, however, the distal phalanges are ankylosed, they lie with their flexor surfaces against the palm of the hand. In grasping an article tightly the distal phalanges are pressed firmly against the palm of the hand by the other phalanges, especially by the middle ones, the wrist being held retroflexed.

While rough work develops the strength of the hand and fingers, skill of movement and a sensitive touch are required for the performance of more delicate tasks. In either case it is necessary that the whole mechanism of the hand should be in perfect order, a condition with which injuries and diseases of the hand and fingers are not compatible.

Statistics.—This chapter is based on an experience with 721 injuries of the hand and fingers, classified as follows :

Injuries due to contusion	222
Crushing and mangling	97
Ordinary fractures	84
Fractures due to crushing of the part	67
Dislocations and sprains	55
Incised wounds	85
Punctured wounds	18
Lacerated wounds caused by nails and splinters	71
Burns	21
Frost-bite	1
	721
Cellulitis	78

The separate fingers were involved as follows :

Thumb	149	(	right side,	80;	left side,	69)
Index-finger	147	(	"	"	66	" " 81)
Middle finger	172	(	"	"	73	" " 99)
Fourth finger	129	(	"	"	54	" " 75)
Little finger	80	(	"	"	34	" " 46)

According to this table, the fingers of the left hand are more frequently involved than those of the right.

Among the total of 677 injuries of the fingers, the metacarpal bones were involved in a large number of the cases.

The hands are especially exposed to injury in every department of industry, hence in statistical tables based on the relative frequency of injuries in different parts of the body they usually stand highest.

Injuries of the Hand Due to Contusion.

These injuries occur when the hand is hit by an object falling from a height, such as a stone or a piece of wood or iron, or by objects falling against the hand, or by blows from a hammer, etc. If the force is applied to the back of the hand, the injury is very likely to consist of a simple or compound fracture of the metacarpal bones. Simple contusions involving the hand or fingers usually heal rapidly and completely.

There is one peculiar injury of the contusion class involving the ball of the thumb. This becomes the seat of an inflammation, which may run a severe course, developing into a cellulitis and rapidly extending up the hand and

arm. Such an inflammation of the left thumb is most frequently seen in masons after vigorous and long-continued counterpressure on the ball of the thumb in the process of chipping unusually hard stones. The lesion occurs in the ball of the right thumb as a result of similar causes, or it may involve the palmar fascia in the middle of the hand instead. If diffuse suppuration sets in, necessitating frequent operation, the hand is usually permanently disabled for its customary work.

In less unfavorable cases the inflammation takes a chronic form, the fascia becoming irregularly thickened and contracted, holding the proximal phalanx of one or more fingers in a position of flexion.

Case of inflammation of the palmar fascia leading to complete stiffness of the hand and fingers.

A workman, thirty-four years of age, developed an inflammation of the palm of the right hand produced by long-continued pressure of the wooden handle of an iron pick which he had used in chipping hard stones. On the day following the hand was swollen; suppuration soon set in, and a series of operations was required.

I examined him on November 7, 1888, and found the wrist and fingers swollen. The wrist presented several scars, which extended toward both the palm and the back of the hand. The hand, fingers, and wrist were completely immobilized.

Mechanical treatment was begun, and was continued until September, 1889. At that time the fingers could be about half closed, enabling the patient to grasp large articles, but not to hold them. Permanent insurance allowance, 40%.

Case of inflammation of the palm of the right hand, followed by recovery.

A carpenter, fifty years of age, worked with a crowbar, which he held braced against the palm of the right hand, on November 6, 1891; on the following day the hand was somewhat swollen, but he continued to work until November 14th, although the hand became more and more painful. Finally he entered a hospital, where a number of operations were performed.

He came under my care on January 1, 1892. The hand and fingers were at that time swollen, while the wrist was partly encircled by a number of scars, some of them deeply attached. Movement of the fingers was restricted. Massage, local baths, and exercises were prescribed.

When discharged, on June 3, 1892, the patient could completely close the hand, and the wrist was also freely movable. The only remaining symptom was a slight weakness of the hand. Insurance allowance, 20%, until October 8, 1896, when functional power was completely restored.

When the hand is crushed by falling weights, such as heavy beams, stones, iron rails, etc., or by being run over, the injury is usually complicated by simple or compound fractures. The worst cases of the kind are seen when the hand is caught and mangled between cog-wheels or between hot rollers in a steam laundry, or when it is crushed by extremely heavy weights. In such cases the bones and soft parts are invariably more or less completely destroyed, so that amputation often becomes necessary. Relatively favorable results, however, are sometimes obtained even after these severe accidents.

Burns of the hand and fingers are of common occurrence, and have a great variety of causes. Thus, the hand may be carried too near a fire, or be brought in contact with a hot stove, burning coals, steam, etc., or be thrust into hot fluids, caustics, lye, or boiling tar, or be spattered by hot fluids, or the burn may be caused by the explosion of an alcohol or kerosene lamp, etc.

The process of healing is frequently protracted, and results in cicatrices, which are likely to be very painful and exceedingly sensitive to pressure for a long time. Although, as a rule, superficial and nonadherent, they are very likely to crack open, especially in cold weather, and when they extend from the hand on to the fingers. Attempts to close the hand may sometimes suffice to cause the scars to break open. The scars are unfavorably affected by cold weather; the hand feels cold and looks blue, and the scars, when they break open, heal more slowly than at other seasons. These effects are not difficult to understand, if we consider how thin, atrophic, and contracted such scar-tissue usually is.

The use of ointments is often beneficial, and in winter vaselin and like substances should frequently be applied, while the scar should also be protected by a bandage when the patient is at work.

The working capacity of the patient may be greatly diminished, particularly if he is unable to hold anything

PLATE 22.

Case of Trophoneurosis of the Hand Following an Accident in Which the Median and Ulnar Nerves Were Severed.

A sawyer, thirty-two years of age, was cut across the left forearm near the wrist by a circular saw on March 26, 1897. The wound was treated antiseptically in the hospital, but severe suppuration set in, necessitating incision. The wound healed by May 10th, and the patient was then discharged from the hospital. He received treatment in my clinic from July 2, 1897, until December 28, 1897.

The illustration shows the scar on the flexor surface of the forearm, reaching to its inner margin and slightly constricting the latter. The fingers are slightly flexed, as if holding a pen. Below the scar the tissues are deeply cyanosed; there are necrotic ulcers on the thumb and on the tips of the middle and fourth fingers. The part is extremely cold, and all the fingers are stiff. Figure 2 shows the atrophy of the interossei on the extensor surface of the hand. Insurance allowance, 55%. No improvement.

in the hand. If his only incapacity is the occasional cracking open of the scar, and if he receives full pay for his work, from 10 % to 20 % is usually a sufficient allowance.

Wounds of the hands are met with in all possible forms and varieties. In addition to classifying them according to their clinical appearance, as incised, punctured, lacerated, etc., a classification based on their etiology proves both interesting and instructive, acquainting us with the special dangers of the various branches of industry and enabling us to make more effectual provision for their prevention.

Scars on the extensor surface of the hand, if adherent to the extensor tendons, have an unfavorable effect on functional power by interfering with flexion of the fingers, and finally, by their retraction, they cause the fingers to become fixed in extension.

Flexion may in other instances be prevented by scars that are adherent to the metacarpal bones. This is the invariable effect of adhesions between the scar and the metacarpophalangeal joint. The fingers are at the same time held slightly extended, while the head of the first phalanx is displaced forward.



Fig. 1.



Fig. 2.

Scars extending down between the metacarpal bones restrict the action of the external interossei, as is evidenced by diminished abduction of the first phalanges of the affected fingers. If nerves are involved in the scars, we usually find paralysis of the fingers, with symptoms of neuritis or neuralgia.

The object of treatment is to loosen the scars and to restore the functional power of the fingers, and in many cases this can be perfectly accomplished by mechanical treatment alone. If deeply attached, however, the scar should be freed by operation, and the success of the procedure should be insured by subsequent mechanical treatment, which should be begun early.

The patient is incapacitated for work in proportion to the loss of functional power of the fingers.

Scars of the palm of the hand interfere with movement of the fingers when adherent to the metacarpophalangeal joints. Such a condition is not always the result of an accident, but is met with likewise after operations. The scars, for instance, consequent upon disarticulation of a finger (third or fourth finger) usually show a strong tendency to retraction, drawing the palm of the hand together like a boat, the more so if much of the metacarpal bone is removed. The two fingers thus brought side by side by the operation show an inclination to remain flexed and for their tips to approximate each other more closely. The other fingers follow suit; the hand can no longer be properly closed, and becomes weak. In addition, the scars of the palm are particularly sensitive to pressure, and frequently give rise to violent attacks of neuritis.

A prolonged and tiresome course of treatment may be required, calling for the exercise of considerable patience. Work should not be resumed until the patient can use the hand for grasping and holding purposes, except when no further improvement can be looked for. The incapacity for self-support is estimated according to the loss of functional power.

PLATE 23.

Case of Contracture of the Wrist in Extension Following Cellulitis. Complete ankylosis of wrist and fingers.

A hod-carrier, forty years of age, in his twentieth year took a nap in his noonday rest, sleeping with his right hand under his head. When he awoke he was conscious of pain in the back of the hand, but continued to work for several days until symptoms of fever and swelling of the hand appeared.

He was treated in the hospital for three months; two months after this he recovered some use of the hand, and although the wrist and fingers have remained completely stiff, he has worked as before as a hod-carrier. He receives no insurance allowance, the injury not having been caused by an accident incidental to his trade.

Scars occupying the center of the hand are not infrequently adherent to the palmar fascia, producing a contraction of the proximal phalanges of the fingers. This condition does not necessarily greatly diminish the usefulness of the hand, however, unless the scar is raised above the level of the surrounding skin, in which case the patient finds it difficult to take a firm grasp of an object, especially if of a hard material. In addition, the scar is constantly exposed to injury.

Scars situated on the ball of the thumb or little finger usually cause no trouble unless they are deeply attached to the underlying tissues.

Sprains of the Metacarpophalangeal Joints.

Sprains of these joints are most frequently caused by a fall on the closed hand, and unless complicated by frac-

PLATE 24.

Case of Stiff Hand Following Cellulitis.

A workman, fifty-nine years of age, on July 10, 1891, scratched his right thumb on a nail projecting from a pail. He was treated in the hospital for the cellulitis that followed, a number of incisions being required.

The accompanying illustration shows the scar of the original wound of the thumb and the scars consequent upon the incisions in the forearm, the ball of the thumb, and the ball of the little finger. It also shows the position of the fingers closed upon the palm, rendering the hand entirely useless. Insurance allowance, 60%.





ture, they usually heal without any difficulty. Inflammation should be treated by compresses. Stiffness is easily overcome by massage and passive movements.

Dislocations of the Metacarpal Bones.

Complete dislocation at the metacarpophalangeal joint occurs with relative frequency in the thumb, but is seldom met with in the other fingers. If a dislocation of this joint in the thumb remains unreduced, it leads to stiffness of the joint, atrophy of the muscles of the thumb, and impairment of the functional power of the hand. The base of the first phalanx projects distinctly backward, while the thumb is held abducted. It is well known that an attempt at reduction often proves unsuccessful; the capsule of the joint or the sesamoid bone at that point may get between the bones, or the tendon of the flexor longus pollicis may become twisted around the neck of the metacarpal bone.

Dislocations of the metacarpophalangeal joints are accompanied by laceration of the capsules and ligaments, which may lead to a subsequent abnormal position of the proximal phalanges of the affected fingers, even after successful reduction.

Subluxation of the phalanges can best be seen by letting the patient first close his hand and then open it, comparing it meanwhile with the normal side.

The mobility of the metacarpophalangeal joint may be restricted by adhesions or may be abnormally free; in either case the patient is unable to flex the finger perfectly, and it often appears atrophied. The atrophy gradually involves the internal interossei, and possibly the lumbricales, and extends in the course of time to the other muscles of the hand.

After the dislocation has been reduced and the swelling has subsided, but very little after-treatment is called for, as a rule, except in cases complicated by paralysis, or when there is ankylosis of the metacarpophalangeal joint,

PLATES 25 AND 26.

Case of Atrophy of the Forearm, and Partially of the Arm, Following an Accident to the Right Hand by Which the Index-finger was Wounded and Dislocated at the Metacarpophalangeal Joint and the Distal Phalanx of the Thumb Was Fractured.

A carpenter, twenty-eight years of age, sustained the foregoing injuries on July 29, 1898, caused by a beam falling on his right hand and his involuntary effort to extricate his hand from under it. The hand was dressed immediately.

He began a course of treatment in my clinic on August 23, 1898. On the palm of the hand near the base of the index-finger there was a small scar; the finger was slightly displaced at the metacarpophalangeal joint, and could neither be flexed nor extended completely. Movement produced crepitation.

The atrophy of the muscles was most noticeable when the hand was compared with the opposite side and when it was tightly closed. The right hand could not be so tightly closed as the left. There was but a slight difference in circumference in the two sides.

Plate 26 shows the atrophy of the muscles of the hand, the ball of the thumb, and little finger, as seen from the palmar surface. The flexion of the index-finger is imperfect. Sometimes the finger is slightly rotated to one side or the other.

due to the growth of adhesions in the joint. The adhesions can gradually be loosened by a course of passive movements and mechanical exercises. It is very important, after reducing the dislocation, to begin the finger-exercises early, before the bandage is removed. Local baths, massage, and electricity are also beneficial in completing the cure. If the hand still remains weak, or its mobility is restricted,—which in the case of the third, fourth, and fifth fingers may be due to adhesions or cicatricial contractions of the tendinous slips connecting them,—the patient may be somewhat incapacitated for work. In such cases an insurance allowance of from 20% to 30% may be indicated.

Fractures of the Metacarpal Bones.

Fractures of the metacarpal bones may occur as the result of direct violence, such as a violent blow or kick



Fig. 1.



Fig 1^a



Fig 1



Fig 1^a

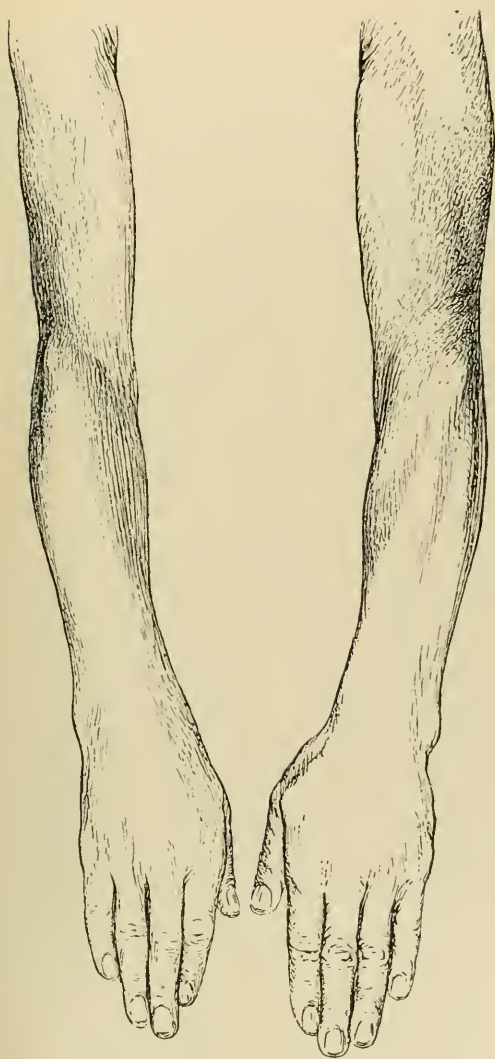


Fig. 42.

PLATE 27.

Atrophy of the Muscles of the Hand Subsequent to a Fracture of the Radius.

A glazier, forty years of age, fell from a ladder from a height of six feet on August 17, 1898. In falling he tried to save himself with the right hand. He was at first treated for a sprain of the wrist. For one week ice-compresses were applied, the subsequent treatment consisting of soap-sud baths and inunctions.

I examined the patient on August 31, 1898. His wrist was swollen and appeared broader than normal; the lower end of the radius was thickened, the enlargement extending down to the carpal bones. The mobility of the wrist was greatly restricted; flexion and abduction were suspended; retroflexion and adduction could be carried to an angle of about twenty degrees. The fingers could be slightly moved, but not closed. The forearm was shortened and supinated. There was atrophy of the hand, forearm, and arm, and also of the shoulder.

The accompanying illustration (Fig. 42) shows both hands and forearms in a position in which the shortening of the right forearm, the supination of the elbow-joint, the atrophy of the whole arm, including the hand, and the enlargement of the wrist-joint are distinctly visible.

The skiagraph (Fig. 43) shows the impaction of the scaphoid in the cancellous tissue of the radius, slight changes in the relation between the carpal bones, and the displacement of the hand.

The colored plate shows a distinct atrophy of the right hand on both the flexor and extensor surfaces, and a reddish-blue discoloration of the skin of the fingers of the radial side of the hand, including the middle finger (radial and median nerves). The temperature of this area was noticeably depressed.

The patient was discharged from treatment on January 26, 1899, with an insurance allowance of 40%, which he has continued to receive. He works ten hours a day, but the condition here described has not improved.

on the back of the hand, or a blow from a heavy object in falling; or as the result of indirect violence, as in case of a fall on the closed hand, the force of which is met by the first phalanx. The symptoms after union has been established vary considerably, depending on the direction of the line of fracture, whether transverse, oblique, or longitudinal, and on whether the fracture involves the end or the shaft of the bone. Displacement in these cases, although seldom very apparent externally, is sufficiently marked to be recognizable and to



Fig. 1.



Fig 1^a



Fig. 2.



Fig 2^a





Fig. 43.

offer an explanation of the symptoms of functional disability that are manifested. As a rule, the fragments are displaced backward, forming a distinct callous convexity on the back of the hand, which can be felt if not seen. The finger appears shortened because of the shortening of the metacarpal bone; frequently, too, the lower fragment of the latter is distinctly rotated, carrying the finger with it. When the head of the metacarpal bone is displaced toward the median line, the corresponding finger is often found to be directed away from it. In other cases, however, the finger is carried toward the middle line. In addition, the base of the bone may be involved in the deformity by being displaced forward, backward, or even to the side. The lateral displacement of one metacarpal bone leads not only to secondary displacement of the adjacent metacarpal bones, and through them to the displacement of the whole row, but affects also the position of the carpal bones and strains the ligament of the carpus. The general displacement thus caused is manifested by diminished mobility and weakness of the fingers and wrist. Occasionally, the head of the metacarpal bone is displaced forward, in which case the corresponding finger can not be properly flexed and the patient is unable for some time afterward to maintain his grasp on an article.

Case of reunited fracture of the third and fourth metacarpal bones and the proximal phalanx of the fifth finger.

A mason, twenty-five years of age, was injured on October 29, 1897, by a box of lime falling upon his right hand.

When I examined him, on December 2, 1897, his hand was still greatly swollen; the third and fourth metacarpal bones were thickened posteriorly, and the metacarpophalangeal joint and proximal phalanx of the little finger were considerably thickened. The patient was unable to flex the little finger at all, and could flex the others only very slightly. The skiagraph (Fig. 44) shows the fractures, and also the displacement of the third and fourth metacarpal bones and the proximal phalanx of the fifth finger.

At the time of his discharge, on June 22, 1898, the patient was able to flex the index-, middle, and fourth fingers so that they almost touched the palm of the hand, while the fifth finger remained about at a right angle. Insurance allowance, 33½%.



Fig. 44.



Fig. 45.



Fig. 47.



Fig. 46.

The chief cause of this disability is the pressure exerted by the head of the displaced metacarpal bone. When, after fracture of the head or base of the bone, accompanied by complete lateral dislocation, the bone becomes fixed in this position, the deformity assumes a serious functional import. Sometimes the base of the metacarpal bone is broken off and driven between the adjacent metacarpal bone and the carpus, while the head of the bone becomes united with the same metacarpal bone on its opposite side. As a natural consequence the hand is broadened and the fingers are considerably displaced. Deformities of this kind are seen when the hand is crushed and mangled between cog-wheels, etc.

Case of deformity of the hand due to its being crushed between cog-wheels. (Figs. 45 to 48, pp. 332 to 335.)

A workman, twenty-four years of age, was injured on October 12, 1897, his right hand being drawn in between cog-wheels. He sustained the fractures that are distinctly to be seen in the skiagraph (Fig. 45), which also shows the displacement of the heads of the bones and one of the fragments of the fourth metacarpal bone lying upon the third metacarpal bone. It was necessary to remove the third and fourth fingers. In the accompanying illustrations (Figs. 46 and 47) the anterior and posterior aspects of the hand are displayed, the fingers being extended as far as possible. The third illustration (Fig. 48) shows the limit of flexion of the fingers, a bit of pencil being held between the thumb and index-finger.

When I first examined the patient, on January 19, 1898, his hand was still so much swollen as to make it appear like a thick and shapeless mass of flesh, possessing no mobility whatever. Insurance allowance at the time of discharge, 75%.

The cases in which fracture of the head of the metacarpal bone involves the whole joint, including the corresponding articular extremity of the proximal phalanx, are usually marked by ankylosis of the midphalangeal joint, as well as of the metacarpophalangeal joint itself, causing the affected finger or fingers, if several are involved, to become fixed in flexion, thus impairing the usefulness of the whole hand. The mobility of the adjacent finger or, in cases involving the third or fourth finger, of the adjacent fingers, is secondarily affected as a rule, so that the hand can be only partly closed.

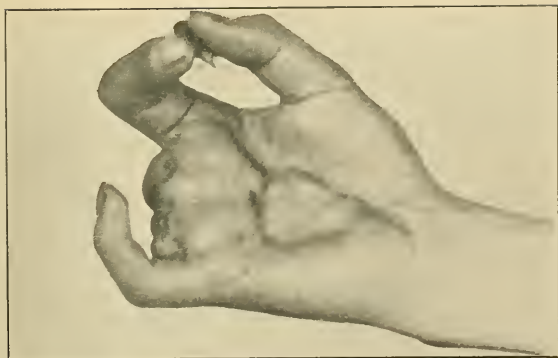


Fig. 48.



Fig. 49.

The following points deserve special mention : Fracture of the first metacarpal bone leads to primary atrophy of the ball of the thumb and to secondary atrophy of the ball of the little finger, the reverse holding good for fractures of the fifth metacarpal bone. Since, in addition, there is an atrophy of the interossei, beginning in the first interosseous muscle, the weakness and functional disability of the whole hand are easily explained, even when no complications exist to further restrict its power.

Fracture of the second metacarpal bone leads to primary atrophy of the first, second, and third interossei, limiting the strength of flexion of the index-finger, and, to a certain extent, that of the thumb and little finger as well. A similar effect is produced by fracture of the fifth or fourth metacarpal bone, and in case of fracture of the third the weakness of the hand is a particularly well-marked symptom, since the third finger is normally the strongest.

Treatment is chiefly a question of restoring mobility to the affected parts, and to this end massage and exercise of the stiffened joints should be carried out with great regularity. Exercises with pulleys, gradually increasing the weights, should be begun as soon as the power of flexion begins to return. Local water-baths and steam-baths are of considerable benefit.

The insurance allowance is estimated according to the functional disability, depending on the number of joints involved, and on the degree to which they are ankylosed. Complete stiffness of a metacarpophalangeal joint calls for a relatively higher rate than partial stiffness.

Case of tuberculosis of the head of the second metacarpal bone, due to metastasis. (Fig. 49, p. 335.)

A little girl, nine years of age, turned her ankle while exercising in a gymnasium, and was treated for about three months for a sprain. She then turned the same ankle again in crossing the street, and was thereafter confined to bed. The ankle became more and more swollen, and an abscess formed, which left several fistulas.

I examined the patient five years later. She was then a thin, sickly, and undersized child, walking on two crutches. The treatment that I instituted consisted of careful irrigation of the fistulas,

regulation of diet, etc. The fistulas healed within a year, but the foot remained much enlarged. Since that time the child has felt well, and has rapidly developed. Two years later a fistula appeared spontaneously on the palm of the right hand, over the second metacarpal bone. There was no pain and no loss of functional power. The skiagraph shows with great distinctness the destruction of the bone by caries.

INJURIES OF THE FINGERS.

Simple contusions of the fingers, unaccompanied by wounds or fractures, hardly call for discussion here, since they cause no subsequent functional disability, unless, as occasionally happens, the injury leads to a tenosynovitis, with subsequent contracture of the tendon.

Great importance, on the other hand, must be placed on the severe injuries that occur when the fingers are caught and crushed under heavy beams, pieces of iron, or weights, when they are caught and compressed between two objects, or struck by a stone, by a hammer, etc. In such cases we have to deal either with simple subcutaneous fractures of the phalanges (which I have observed almost invariably after these injuries) or with severe comminuted fractures, for which immediate amputation is often indicated. It is not unusual for the accident itself to cause the complete or partial amputation of one or more fingers. This is especially likely to occur when the hand is mangled by being drawn in between cog-wheels.

In respect to the wounds of the fingers with which we have to deal, it will suffice to mention a few of the most important varieties. Incised wounds caused by sharp knives and similar instruments, if they involve tendons, nerves, and vessels, are followed by ankylosis, paralysis, and atrophy. Slight lacerations caused by nails or splinters, or even superficial scratches, may lead to severe cellulitis (blood-poisoning). Incised wounds caused by sharp-bladed machines, such as circular saws or planing machines, are always grave injuries, causing various degrees of mutilation; one or more fingers or parts of fingers are

PLATE 28.

Case of Mutilation of the Fingers by a Circular Saw.

A sawyer, forty years of age, on December 28, 1897, had his index-finger, middle finger, and thumb cut through the bone by a circular saw.

The colored plate shows the deformity of the fingers both from the flexor and extensor surfaces. The accompanying skiagraph (Fig. 50) shows the changes that have taken place in the injured joints of the index-finger and middle finger. The thumb could not be directly approximated to the plate in taking the skiagraph without causing the impression to lose in clearness. Insurance allowance, 45%, based on the inability of the patient to close the affected fingers.

usually cut off, or the wound extends so deeply into the tissues as to sever muscles, tendons, vessels, nerves, and even the bone.

The joints of the fingers are occasionally sprained by violently pulling at an object or by the effort to free the fingers when they are caught fast. The capsules and lateral ligaments of the joints, especially of the metacarpophalangeal joints, are strained and slightly torn, leaving the joint weakened, so that for some time afterward the patient finds himself unable to grasp and hold an object with his accustomed strength.

Similar symptoms, but often intensified, are observed after dislocation of the joints of the fingers. The symptoms of dislocation of the metacarpophalangeal joints have already been discussed. When the other two joints of the finger are involved, the patients complain for some time after reduction is practised of pain and a feeling of weakness, especially when they close the hand or hold something in it. Sometimes dislocation is accompanied by fracture of the phalanges.

Ankylosis of the affected joint is more frequently a sequel of a subluxation than of a complete dislocation, since the former is apt to be treated as a sprain and left unreduced.

Treatment.—Mechanical treatment usually proves suc-



Fig. 1.



Fig 1^a



Fig. 50.



Fig. 51.

PLATE 29.

FIG. 1.—Case of Loss of the Little Finger, together with the Head of the Fifth Metacarpal Bone.

A workman, forty-one years of age, sustained a comminuted fracture of the metacarpophalangeal joint of the little finger of the left hand, caused by the finger being struck by a beam. The little finger and the head of the fifth metacarpal bone were amputated.

The colored plate shows the scar left by the operation and the extent to which the hand can be closed. The fourth finger does not quite touch the palm of the hand. The accompanying illustration in black and white (Fig. 51) shows the hand when fully extended. The fourth finger is held slightly abducted from the median line by the tension of the scar, causing the skin over the extensor tendon of the middle finger to appear like a distinct fold.

FIG. 2.—Adherent Scar Over the Metacarpophalangeal Joint of the Index-finger, Due to an Incised Wound Partly Severing the Bone of the Joint.

A machinist, thirty-two years of age, was cut in the left hand by a circular saw on January 29, 1892, the wound opening the joint. The plate shows a star-shaped scar adherent to the bone and a partial forward dislocation of the finger. The power of flexion and extension of the finger has never been completely regained, and the strength of the hand is slightly diminished.

Insurance allowance, 15%.

cessful. The patient is, as a rule, only slightly incapacitated for self-support.

Fractures of the Fingers.

These are usually direct fractures, and may be caused by blows from falling objects, blows from a hammer, or by falling and striking on the finger. Indirect fractures of the distal phalanges are said to have occurred as a result of the tension of the extensor tendons when the fingers were forcibly flexed. The majority of phalangeal fractures occur in consequence of severe crushing of the hand.

The following symptoms are manifested after union is established :

The finger is usually thickened at the point of fracture ; sometimes it appears broadened and shortened, and not infrequently it appears convex or concave on its flexor or extensor aspect. If the fracture involves a joint, the fin-



Fig. 1.



Fig. 2.

ger becomes stiff and fixed in a position of flexion or extension.

The position of the adjacent fingers is not infrequently affected, and their mobility may be restricted.

Treatment.—Passive movements should be begun early, especially when the fracture involves a joint; the fingers should be exercised frequently, even while the bandage is maintained, the latter being adjusted with this in view.

Crushing of the distal phalanges is frequently followed by suppurative inflammation of the nail-bed. If not removed by the physician, the nail is usually thrown off of itself, and the new nail that grows in is poorly developed

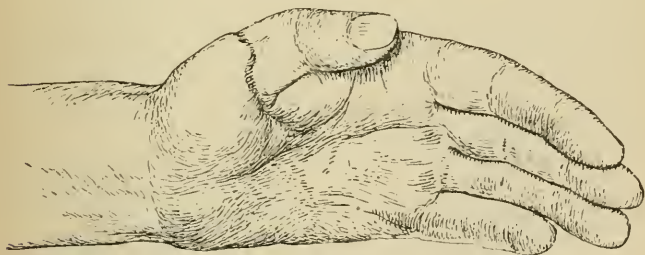


Fig. 52.

and misshapen, merging in the surrounding skin. The distal phalanx is held slightly flexed, and can neither be completely flexed nor extended. It may be very painful, especially if a neuroma develops.

No after-treatment is required, as a rule, unless the affected phalanx is exceedingly stiff and painful, in which case local baths and massage usually effect a recovery.

The presence of one stiff finger is a source of great inconvenience to a working-man, making it difficult to take hold of an object, while the finger itself is constantly hitting against something and being freshly injured. Moreover, it interferes with free movement on the part of the adjacent fingers. This is most noticeable when the third

PLATE 30.

FIG. 1.—Case in Which the Middle Finger Became Shortened and Stiffened as a Result of Gangrene from the Use of Car-bolic Acid.

A workman, thirty-nine years of age, lacerated his right middle finger on a nail on December 2, 1898. He paid but slight attention to the wound, simply sucking it out and binding a rag around it. He continued to work until the third day after the accident, when his finger became swollen, inflamed, and very painful. It was opened by a physician, who then washed out the wound with what purported to be a 5% solution of carbolie acid. The tip of the finger is said to have turned black at once. The patient would not permit the amputation of the gangrenous portion, which was thrown off by natural processes in the course of about two months. Mechanical treatment was then begun, the patient being unable to close his hand. The middle finger was perfectly stiff, the fourth finger and index-finger could be closed one-third, the fifth finger somewhat further. The patient was not able to take hold of anything with his hand. Treatment was continued up to October 24, 1898, when he was discharged with an insurance allowance of 40%. The functional power of the hand was sufficiently restored to enable him to take hold of large objects.

FIG. 2.—Case of Paralysis of the Ulnar Nerve due to Crush-injury of the Left Shoulder.

The illustration shows a well-marked atrophy of the interossei and the position of flexion in which the fingers are held. The paralysis appeared about two weeks after the injury, the hand at the same time becoming greatly swollen.

Mechanical treatment has brought about gradual improvement; the patient has not yet been discharged.

or fourth finger is involved, especially in case of the third. It is, as a rule, much more disadvantageous to a working-man to have a stiff middle finger than to lose it outright.

Case of pseudo-arthritis of the left thumb due to an incised wound by a cutting machine.

A workman, twenty-three years of age, was cut through the proximal phalanx of the left thumb by a cutting machine on October 20, 1890, the bone being completely severed. A false joint developed, and the thumb remained entirely useless for a long time. The illustration (Fig. 52) shows the deep scar around the thumb and the ball of the thumb.

The patient received an insurance allowance of 45% up to March 15, 1892, based on his inability to use the hand and the atrophy of the whole arm. Improvement gradually took place, and the allowance was reduced to 25%, at which rate it has remained. The thumb is still rather weak.



Fig 2.



Fig. 1



Fig 1^a





Fig. 53.



Fig. 54.



Fig. 56.



Fig. 55.

Case of crushing and fracture of the left thumb caused by an iron pipe falling upon it.

The lesion was treated as a simple case of crushing of the thumb.

I examined the patient on June 30, 1898, and found the thumb still swollen and reddened, presenting a suppurating wound on its posterior surface. The wound was dressed at my clinic on July 8th, but the patient did not again return, as he resumed work on the day following. The accompanying skiagraph (Fig. 53, p. 343) shows the condition of the thumb at that time. No insurance allowance.

Case of subluxation and ankylosis of the distal phalangeal joint of the right thumb caused by crushing of the thumb and subsequent cellulitis.

The patient was a workman, thirty-three years of age. A hod filled with lime fell on his right thumb, which he bandaged with a piece of paper and tied with a string, then continuing his day's work. On the following day the part became swollen, the swelling finally extending to the shoulder.

When discharged from treatment he was conceded an insurance allowance of 20%, based on the partial ankylosis of the thumb and weakness of the hand.

The skiagraph (Fig. 54, p. 343) shows the subluxation of the distal phalanx of the thumb and the changes in the bones of the joint.

Case of bony union in the distal phalangeal joints of both thumbs following fracture. (Fig. 55, p. 343.) Sequel, unimpaired usefulness of the thumbs.

The patient had injured the right thumb in his fourth year by falling and directly striking upon it; the left thumb was injured much later, but also before the passage of the Accident Insurance Law. The functional power of both thumbs is excellent, notwithstanding the fact that the distal phalanx of the right thumb is entirely stiff.

A stiff finger, if flexed, is more favorable to the usefulness of the hand than if extended, partly because it may aid the other fingers in grasping and holding articles, partly because it is much less in the way.

Case of dislocation-fracture of the left thumb, with subsequent ankylosis. (Fig. 56.)

The patient was a workman, thirty-nine years of age. On July 12, 1889, a plank fell upon his left thumb, producing a fracture of the proximal phalanx. The upper fragment became displaced backward, and union took place in this position. The thumb can not be completely flexed.

Insurance allowance since October 12, 1889, 10%.

Contractures of the fingers by which they are retained in a position of flexion are very frequently seen. They may be caused by a contracture of the tendon following a tenosynovitis (a condition quite often met with as a

professional disease in certain trades) or by a retracted scar. Occasionally, the cause is a mixed one, the scar left by an operation having become adherent to the flexor tendon.

The scars left on the stump of a finger after amputation often become firmly adherent to the bone, and are exceedingly sensitive both to pressure and to changes of temperature. They are also apt to give rise to a painful feeling of tension on closing the hand.

Occasionally, such a stump becomes the seat of a neuroma. This is more likely to occur if the stump is a broad one, as when it includes a part of the distal phalanx. Neuromata develop more frequently in the cases in which the finger is cut off by a machine, such as a circular saw or planing machine, and especially when it is crushed off between cog-wheels, than after an amputation by the surgeon. The presence of a neuroma impairs the functional power of the part to a much greater extent than does the simple loss of the tip of the finger. The usefulness of the stump of a finger depends, of course, on its length; even if only the proximal phalanx is left, it is of assistance in maintaining a grip on an object. If painful and sensitive, a stump is rendered comparatively useless.

The scars that follow disarticulation of the finger at the metacarpophalangeal joint become retracted, and in case of removal of the middle or fourth finger, cause the tips of the fingers to either side to approach each other, a change of position often associated with a slight rotation of the fingers. Their flexion is often restricted for a long time afterward.

The position of the adjacent fingers is more likely to be thus affected when a portion of the metacarpal bone is also removed; the scar is thereby made larger, while the palm of the hand is narrowed or drawn together in the shape of a boat. Neuritis is sometimes manifested in severe form in connection with these scars.

The removal of the fifth finger with a portion of its metacarpal bone is usually followed by retraction of the scar, causing the fourth finger to become abducted from the median line and preventing its complete flexion. (See Plate 29, Fig. 1.)

Of the diseases of the fingers, we need here consider only the paralyses and the trophoneuroses accompanied by necrotic ulcers. The former occur in consequence of direct injury of the nerves, and also of indirect injury: as, for instance, the paralysis of the median nerve which is quite often met with in cases of fracture of the radius. The latter, the trophoneuroses of the fingers, are observed when the ulnar or median nerve is completely severed.

Case of compound comminuted fracture of the proximal phalanx of the left index-finger.

A workman, twenty-two years of age, sustained the foregoing injury on March 21, 1898, caused by a stone from a wall falling on his left index-finger from a height of two stories.

I examined him on April 6, 1898. The index-finger was swollen and could not be flexed. Up to that time the injury had been treated as a simple case of crushed (contused) wound of the finger. When discharged from my treatment, on April 16, 1898, at his own request, the finger was in the condition shown in the accompanying skiagraph. (See Fig. 57.) The patient was fully capable of self-support.

Case of fixation in extension of the right index-finger.

The patient in this case was a potter, twenty-four years of age. His right hand was caught between a beam and an overturned barrel of clay, causing a contused wound of the right index-finger, accompanied by a partial dislocation-fracture of the middle phalanx.

When I examined him, on September 2d, I found the finger moderately extended and fixed in that position. It was stiff and much atrophied; the middle phalanx was encircled by a deep scar. The skiagraph shows the deformity of the bone. In figure 58 the finger lay with its flexor surface against the plate, while in figure 59 the side of the finger was applied.

The patient has received an insurance allowance of 25% since October 25, 1897, based on the fact that the index-finger is stiff, is constantly in the way, and is depressed in temperature.

Case of fracture of the distal phalanx of the fourth finger of the right hand, caused by a stone falling upon it.

A workman, thirty-three years of age, sustained the foregoing injury. He was treated by cold compresses, and subsequently by ointments.

When I examined him, I found the finger swollen. The condition of the bone is shown in the accompanying skiagraph. (Fig. 60, p. 347.)

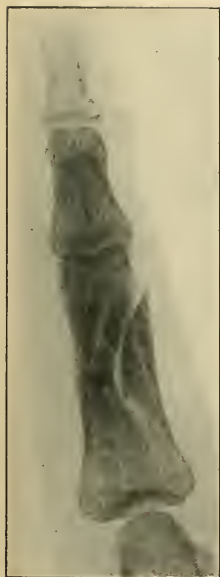


Fig. 57.



Fig. 58.



Fig. 59.



Fig. 60.



Fig. 61.

The patient was unable to close the middle, fourth, and little fingers completely. He continued to work in this condition with the fingers bandaged, and did not return for treatment.

Case of crushing and fracture of the distal phalanges of the middle and fourth fingers of the right hand. (Fig. 61, p. 317.)

The patient was a hod-carrier, forty years of age. On July 22, 1898, the previously designated fingers of the right hand were crushed between two iron girders. The wound was dressed by his own physician, who treated him for a crushed finger until December 12, 1898. At first both distal phalanges were greatly swollen, thickened, and knob-like. When discharged by his physician, the swelling had disappeared; nevertheless, the skiagraph showed a separation of the fragments, as here reproduced.

The patient was considered by the insurance committee of his trade-union to be able to work, and received no insurance allowance.

Case of a stiff right index-finger with adherent scars on the flexor surface.

A workman, fifty-two years of age, lacerated the right index-finger on a splinter when engaged in cutting wood. He paid no attention to the wound at first. A few days later the finger became swollen, the swelling extending to the hand and arm. Cellulitis was diagnosed and an operation was performed. The flexor tendon was subsequently removed.

Insurance allowance, 20%.

Case of loss of one-half of index-finger, of almost one-half of the middle finger, and of one-half of the distal phalanx of the fourth finger.

The patient was a sawyer, thirty-two years of age. On April 9, 1897, his left hand was caught in a planing machine and the fingers cut off, as previously mentioned.

After the wounds had healed, the patient was able to flex the fourth and little finger perfectly; the stump of the middle finger could be flexed at the metacarpophalangeal joint to an angle of 130 degrees, while the stump of the index-finger could not be flexed at all. The strength of the hand was diminished.

On October 21, 1897, the patient was conceded an insurance allowance of 33 $\frac{1}{3}$ %, which was later raised by legal process to 40%. It was reduced to 25% on April 15, 1898, improvement in respect to flexion and strength having taken place. The patient receives full pay for his work.

Case of dislocation of the third, fourth, and fifth fingers of the left hand at their metacarpophalangeal joints. The lesion was caused by a beam falling on the fingers.

The patient, a carpenter, forty-five years of age, sustained the foregoing injury on February 3, 1892. The dislocation was reduced, but the metacarpophalangeal joint of the middle finger remained abnormally movable. The whole hand, as well as the middle finger, was much weakened. The patient was unable to exert firm pressure with the middle or fourth finger; symptoms of paresthesia and of ascending neuritis were also manifested. Insurance allowance, 40%; the patient died subsequently of an internal disorder.

Case of severe crushing of the right middle finger. Sequels: The affected finger became much shortened and ankylosed in a position of flexion; the whole hand could be only partly closed.

A workman, sixty-three years of age, the subject of this case, is unable to use his hand for work, and receives an insurance allowance of 50%.

Case of disarticulation of the right middle finger. Prolonged course of surgical treatment and severe neuritis lasting for a long time.

A workman, twenty-four years of age, was injured on December 6, 1889, by a stone falling on the right middle finger. Suppuration set in, and the finger was finally disarticulated on August 11, 1891. An attempt had been made to preserve the finger in a position of flexion, but this was given up because the finger became closely pressed against the palm of the hand.

The patient subsequently attended several different clinics, finally going to a clinic for nervous diseases, where he was treated for a neuritis of the median nerve by massage and electricity.

On May 15, 1893, he was conceded an insurance allowance of 60%, which by legal process was raised to 80%. He was under treatment for three and a quarter years.

In 1895 it was discovered that he was again at work, and was receiving full pay. His insurance allowance was accordingly reduced to 35%. He had not recovered the power of closing his hand until about the year 1895.

Case of disarticulation of the middle finger subsequent to crushing of the finger and cellulitis. (Fig. 62.)

The subject of the accompanying illustration, which was made on the day of his discharge, was a workman, thirty-one years of age. The imperfect closure and the convergence of the fourth and fifth fingers are distinctly shown. The accident occurred on September 29, 1898, and the finger was disarticulated on December 5, 1898. The patient was given a course of after-treatment lasting from January 6, 1899, to May 20, 1899. Insurance allowance, 25%.

Case of contracture of the right middle finger in a position of flexion, causing severe functional disability of the hand, rendering it useless for a long time.

The patient was a workman, forty years of age. On July 11, 1892, an iron girder fell upon the middle finger of his right hand; the injury was followed by a suppurative inflammation, necessitating deep incisions in the finger.

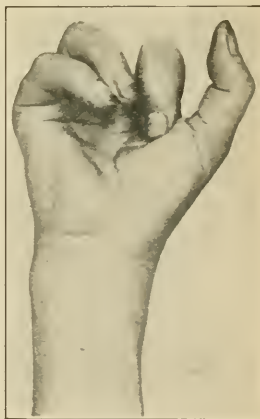


Fig. 62.

When I examined the patient on October 6, 1892, I found the middle finger slightly flexed and quite stiff. The other fingers, with the exception of the thumb, could not be closed. The muscles of the hand were greatly atrophied, the hand felt cold and numb to the patient, while the scar and the whole palm of the hand were exceedingly sensitive.

The patient remained under treatment until June 20, 1893; he was conceded an insurance allowance of 50%, which was later reduced to 40%. By September 10, 1896, the condition had somewhat improved; the patient could close his fingers somewhat better, and the hand, although still weak, presented a more normal appearance. The insurance allowance could not be reduced.

Case of removal of the fourth finger.

The patient, a carpenter, forty-five years of age, sustained a compound comminuted fracture of his fourth finger on October 25, 1889. The injury was caused by his finger being caught in the guy-rope of a flagstaff. The finger was removed. The operation-scar extended to the palm of the hand and prevented the closure of the index-finger and the middle and little fingers. The hand became atrophied and paresthetic; the scar was exceedingly sensitive. The patient was discharged on March 20, 1891, with an insurance allowance of 40%, afterward raised by legal process to 55%.

Case of complete contracture of the fourth and fifth fingers and almost complete contracture of the index-finger and middle finger of the left hand, following an accident by which the tendons were severed at the wrist.

A roofer, twenty-eight years of age, fell from a roof about fifteen feet high, on April 7, 1887, striking the left wrist against a sharp-edged slate tile. He was treated in the hospital for a number of weeks, and afterward received electric treatment from a nerve specialist. No improvement was attained.

Insurance allowance, 60% at first; raised by legal process to 80%, later reduced to 50%. The hand can be used with difficulty as an adjunct to the right hand.

Case of crushing of the distal phalanges of the index-finger and of the middle and fourth fingers. Sequels, rudimentary formation of the nails and inability to flex completely the affected fingers at the distal phalangeal joints.

A carpenter, thirty-four years of age, sustained the foregoing injury, which was caused by his hand being caught between a rope and a cleat. After the wounds had healed, the fingers could at first be neither completely flexed nor extended. The patient was allowed 20% insurance on account of the impairment of functional power and of a slight flexion contracture of the fingers.

Case of severe contracture of the right middle finger, the tip of the finger being in contact with the palm of the hand.

The patient was a man thirty-five years of age, of delicate health. The contracture of the finger dated from a previous injury, but was increased by a suppurative inflammation, which originated in a slight laceration of the finger. The insurance allowance was only 10%.

The patient is able to hold articles that are placed in his hand.

Case of removal of the distal phalanges of the index-finger and of the middle and fourth fingers of the left hand.

The patient was a workman, fifty-four years of age. On September 29, 1892, his left hand was caught between the rope and the drum of an elevator, crushing the previously mentioned fingers, and necessitating amputation of the distal phalanges. The hand became entirely useless. Insurance allowance, 50%. On November 10, 1893, the patient sustained a fracture of the third metacarpal bone of the right hand, for which injury an insurance allowance of 10% was conceded, giving a total allowance of 60%.

Estimation of Indemnity for the Sequels of Injuries of the Hand and Fingers.

The following scale of indemnity rates was at one time employed in a number of trades-unions :

Loss of thumb	right, 25% ; left, 20%
“ index-finger	“ 18% ; “ 14%
“ middle finger	“ 13% ; “ 10%
“ fourth finger	“ 9% ; “ 7%
“ little finger	“ 12% ; “ 9%

The loss of a phalanx of the thumb was considered to equal one-half the loss of the entire thumb; in case of the other fingers, the loss of one phalanx equaled one-third the loss of the entire finger.

This table has been changed in various ways. It was found to be more practicable to make use of round figures, such as 20% or 15%, instead 18% or 14%. Further changes were induced by a recognition of the justice of placing a higher estimate, in many cases, on the loss of the middle finger than on the loss of the index-finger.

I have personally come to allow 30% for the loss of the entire right thumb; 20% for the right middle finger and 15% for one of the other fingers. In case of the left hand, I allow 25% for the thumb, 15% for the middle finger, and 10% for one of the other fingers.

In a paper read at the meeting of German naturalists and physicians held at Brunswick in 1897, J. Riedinger proposed a different basis for the estimation of indemnity for the fingers, for which he adduced physiologic and practical reasons. He states that as the usefulness of the human hand depends less upon its strength than on the harmonious action of all the fingers, it is unreasonable to differentiate between them in respect to indemnity, except in the case of the thumb. The middle finger is the strongest, as becomes very evident when it is lost. The index-finger, however, directs the action of the other fingers, and displays the best-developed tactile sense of all. Its relative value, therefore, is equal to that of the middle finger. The little finger forms the lateral termination of the row of fingers, just as the ball of the little finger forms the boundary of the hand. If the little finger is removed, the muscles of the ball of the little finger undergo considerable atrophy. In order to exert any strength,

however, the little finger is obliged to act in unison with the fourth finger. Because of the close relation and interdependence of the fingers, the loss of any one of the other fingers should in some respects be rated higher than the loss of the index-finger.

Each finger, therefore, has its own specific value, and its loss is felt by the whole hand. The unfavorable effect of the loss of a finger is greater the more of the metacarpal bone is removed.

Riedinger also disputes the justice of rating the right hand higher than the left, claiming that the special work performed by the latter deserves equal consideration. He admits, however, the impossibility of overcoming the deep-rooted prejudice in favor of the right hand all at once, and takes this into consideration in preparing the following table, which I cite here for the reason that it has certain distinct advantages over the others in use, especially in regard to the rates for the loss or partial loss of several fingers.

WHEN THE HAND PROPER IS INTACT.

40 (30) %				
Thumb.	Index-finger.	Middle Finger.	Fourth Finger.	Little Finger.
25 (20) %	15 (10) %	15 (10) %	15 (10) %	15 (10) %
40 (30) %		25 (20) %	25 (20) %	
50 (40) %			40 (30) %	
50 (40) %				
75 (60) %				

WHEN THE HAND PROPER IS AFFECTED.

55 (45) %				
Thumb.	Index-finger.	Middle Finger.	Fourth Finger.	Little Finger.
35 (30) %	25 (20) %	25 (20) %	25 (20) %	25 (20) %
55 (45) %		35 (30) %	35 (30) %	
65 (50) %			55 (45) %	
65 (50) %				
75 (60) %				

I also fully agree with Riedinger in his assertion that the disarticulation of a finger impairs the usefulness of the hand to a much greater degree than an amputation of the proximal phalanx.

In estimating the allowance for stiffness of a finger, the loss of the functional power of the adjacent fingers must be taken into consideration. If only the metacarpophalangeal joint is stiff, and the other fingers are not affected, the injury should be rated at two-thirds of the entire finger. If the midphalangeal joint, however, is stiff, the rate should equal that for the loss of the entire finger.

The rate for a completely ankylosed or paralyzed finger should be higher than for the complete loss of a finger, since it is constantly in danger of being hit and injured.

Stiffness of a distal phalanx does not limit the usefulness of the hand.

The thumb, even if completely stiff, may be quite useful, as it retains its power of opposition.

The contracture of a finger, if it has progressed so far as to bring the end of the finger into contact with the palm of the hand, disables the whole hand for working purposes. If the contracture is less far advanced, and the hand can be used for taking hold of objects, there may be no loss of working capacity.

The most unfavorable results of contracture are seen when the metacarpophalangeal joint is involved; contracture of the midphalangeal joint ranks second in this respect. A contracture of the distal phalangeal joint does not restrict the working power of the patient.

For the rating of the loss of part of a finger I refer the reader to the table. If only one-third of the finger is lost, its usefulness is only slightly impaired; if more than two-thirds are lost, the rate equals that for the loss of the entire finger.

The rates as here cited may call for considerable modification if functional power is further impaired by such complications as painful scars, cicatricial adhesions, callosities, neuromata, etc.

VI. INJURIES AND TRAUMATIC DISEASES OF THE LOWER EXTREMITY.

Remarks Concerning the Anatomy and Function of the Pelvis and Hip-joint.—In distinction to the upper extremities, which, by the arrangement of their various joints, are so admirably equipped for grasping and holding, the lower extremities have the function of supporting and moving the body.

The two innominate bones are separated posteriorly by the sacrum, which is, as it were, swung between them on the posterior sacro-iliac ligaments. The weight of the body, supported by the spinal column, is transmitted through the sacrum and the hip-joints to the lower extremities. The pressure on the sacrum from above causes the posterior ligaments of the pelvis to become tense, drawing the posterior portions

of the ilia toward the median line, thereby increasing the pressure exerted on the sacrum by the innominate bones on each side. The greater the weight to be supported, the more tightly is the sacrum wedged in between the innominate bones.

The hip-joint, which is formed by the acetabulum on one side and the head of the femur on the other, is a limited ball-and-socket joint. The cavity of the acetabulum is deepened by the cotyloid ligament, which acts as a valve, preventing the entrance of air into the joint. Even when all the soft parts connected with the joint, including the capsule, are removed, the head of the femur will not slip out of the acetabulum as long as the cotyloid ligament remains intact.

The capsular ligament is thin in certain places; it is strong anteriorly, where it is reinforced by the iliofemoral ligament. This ligament is so strong that overtension on its part is capable of causing a fracture of the neck of the femur, and it occasionally forms an insuperable obstacle to the reduction of a dislocation of the hip-joint. It serves to limit the extension of the hip-joint, or the bending of the trunk backward; its chief function, however, will be referred to further on. Internally, the capsular ligament is supported by the pubofemoral ligament, tension of which prevents overabduction of the thigh. Abduction is also limited by contact between the great trochanter, or the neck of the femur, and the side of the pelvis. It is between the iliofemoral and pubofemoral ligaments that the weakest portion of the capsular ligament is to be found. Overadduction of the thigh is prevented by the tension of the iliofemoral ligament, and also by the ligamentum teres in cases in which the latter is very short. It is generally admitted that the ligamentum teres is not capable of retaining the head of the femur in position; it is regularly torn through in cases of dislocation of the joint, unless it is abnormally long (from 8 to 10 cm.). In the latter case it may interfere with reduction by becoming caught between the bones. Unusual length of the ligament may also act as a cause of congenital dislocation of the hip-joint. It transmits the acetabular artery, which is very important in connection with the synovial secretion of the joint. The artery is said to terminate before reaching the head of the femur.

A mass of fat surrounded by synovial membrane lies on the floor of the acetabulum, where the ligamentum teres is inserted; it serves to protect the acetabulum at this, its weakest point. When an abscess of the hip-joint breaks into the pelvis, or when an abscess passes out of the pelvis into the hip-joint or on into the iliac bursa, it is at this point that perforation usually takes place.

The fibrous layer of the joint-capsule is inserted below, along the spiral line of the femur, the synovial lining being inserted one centimeter higher on the bone. Posteriorly, both fibrous and synovial sheaths are inserted on a line running across the neck of the femur about half-way down. The psoas and iliac muscles are separated from the capsular ligament by a bursa,—the iliac or subiliac bursa,—which, as a rule, does not communicate with the capsule of the joint, although cases in which such a communication does exist are often met with, especially in old age. As already stated, abscesses may

pass from this bursa into the hip-joint, and so into the pelvic cavity, or vice versa.

The hip-joint permits of the following movements :

1. *Flexion*.—The thigh can be flexed on the trunk, when the knee is bent, to an angle of about 115 degrees (angle between trunk and thigh, 65 degrees); when the knee is extended, to an angle of about 75 degrees (angle between trunk and thigh, 105 degrees). This movement is produced by the iliopsoas muscle (supplied by the anterior crural and anterior branches of the lumbar nerves).

Extreme flexion is accompanied by a certain degree of outward rotation. During flexion the iliofemoral ligament is relaxed.

2. *Extension*.—The thigh can be extended to an angle of about 30 degrees (angle between trunk and thigh, 150 degrees). The muscle here concerned is the gluteus maximus, supplied by the inferior gluteal nerve. During extension the iliofemoral ligament is put on the stretch.

3. *Abduction*.—This movement can be carried to an angle of about from 30 to 40 degrees (angle between trunk and thigh, from 150 to 140 degrees). The muscles in action are the gluteus medius and gluteus minimus, supplied by the superior gluteal nerve. Extreme abduction is accompanied by a certain degree of inward rotation.

4. *Adduction*.—This movement can be carried to an angle of about 30 degrees (thigh and trunk form a supplementary angle of 150 degrees when one leg thus crosses the other). The muscles concerned are the several adductors, the pectineus, and the gracilis, supplied by the obturator nerve.

5. *Rotation* :

(a) *Outward Rotation*.—This is produced by the pyriformis, the obturator internus, the gemelli, and the quadratus femoris (supplied by branches from the sacral plexus), and by the obturator externus (supplied by the obturator nerve).

(b) *Inward Rotation*.—This is produced by the anterior fibers of the gluteus medius.

Statistics.—The 2403 cases of recovery from injuries of the lower extremity supplying the material for the following sections involved the different regions as follows :

Pelvis, including hip-joint	169 cases.
Thigh	248 "
Knee, including patella	339 "
Leg	346 "
Ankle-joint, including malleoli	711 "
Bones of the carpus	304 "
Foot proper, or sole and back of the foot	169 "
Toes	117 "

2403 cases.

I. INJURIES OF THE PELVIS.

(Sixty-eight Cases.)

Contusions of the Buttocks.

The buttocks, by reason of their protected position, are insured against serious effects from contusions, unless the injury is a severe one, such as a fall in a sitting posture.

Such an accident may cause :

1. A more or less extensive hemorrhagic extravasation, which, as a rule, soon becomes absorbed.

2. A severe contusion of the sciatic nerve, followed by neuritis. Traumatic sciatica may also occur as a result of falling when in a squatting position, so as to bring the buttocks into contact with the heel of the boot. Lumbago may be associated with the sciatica.

The **symptoms** of traumatic sciatica are precisely similar to those of the nontraumatic form, except that in the early stages the former is usually accompanied by signs of external injury. Recovery may be extremely slow; particularly obstinate cases are marked by the development of a scoliosis.

Recovery is best promoted by warm baths, massage, applications of ether, medicomechanical exercises, and weak galvanism. Some patients respond more quickly and satisfactorily to a strong faradic current. Others are unable to endure massage at all. The idiosyncrasy of the patient must therefore be taken into consideration in the treatment.

When the sciatic nerve is severed by a fall against the blade of a hatchet or other sharp-bladed instrument, the injury can be successfully repaired by nerve-suture, in which procedure lies the only possible hope of preventing severe paralysis.

The patient is entirely incapacitated for self-support as long as he suffers from pain in the limb and from inability to walk well or to walk at all. Other cases must be

judged according to the severity of the pain and its effect on the patient, whose working capacity, if the pain is slight, is not necessarily impaired at all.

The anatomic relation of the parts explains the frequent involvement of the hip in cases of contusion of the buttocks.

Case of contusion of the buttocks leading to chronic synovitis of the hip-joint.

A painter's apprentice, seventeen years of age, fell from a roof nine feet high on January 16, 1896, striking on the buttocks. He was treated at home for nine weeks by rest in bed and inunctions, and was then taken to the hospital for six weeks, during which time an extension apparatus was applied. Eighteen weeks after the injury he began to do light work.

I examined him on September 6, 1899. He was undersized; the right side of the pelvis was depressed below the level of the left side. The distance from the umbilicus to the anterior spine of the ilium measured 15 cm. on the right side and $11\frac{1}{4}$ cm. on the left side, when the patient was standing; the distance from the iliac spine to the ground was 83 cm. on the right side and 90 cm. on the left side. The distance from the trochanter to the ground was $83\frac{1}{2}$ cm. on both sides. The mobility of the right hip-joint was restricted, and the knee was held slightly flexed. The patient limped when he walked. The muscles were atrophied on the right side, the circumference of the limb being $3\frac{1}{2}$ cm. less than that of the left side.

The skiagraph showed no changes in the bones.

Diagnosis.—Chronic synovitis of the right hip-joint.

Insurance allowance, $33\frac{1}{3}\%$.

Fractures of the Pelvis.

(Forty-seven Cases.)

As a rule, this lesion is met with only in cases of severe accident, such as falling from a height on the buttocks, or being run over, caught under a falling building, or crushed, when lying prone, by the fall of a heavy object, such as a beam, block of stone, etc. When the fracture is caused by being run over or crushed under falling walls, we are likely to find a fracture or dislocation of the sacrum as well. A fracture of the pelvis, if complicated by lesions of the urethra or of any of the pelvic organs, is always to be regarded as a grave accident.

The following **symptoms** are observed in the later stages of the injury :

In cases of fracture of the ilium the anterior superior spine lies, as a rule, on a lower level than that of the opposite side. The affected side of the pelvis is usually narrowed by a transverse fracture of the ilium, caused by direct violence on the side, and the distance between the umbilicus and the anterior superior spine is decreased. The lower extremity is apparently, but not actually, shortened by a fracture of the ilium. This fact can easily be determined by measuring the patient when standing and when lying down. When standing, the distance from the anterior superior spine to the ground is shortened ; if, however, we measure from the apex of the great trochanter to the spine or crest of the ilium, and then from the trochanter to the apex of the external malleolus, we find that no real shortening exists. The line between the anterior superior spine and the trochanter is shorter on the affected side ; the trunk is somewhat inclined toward that side, and the spinal column presents a corresponding degree of scoliosis. Frequently, the leg of the injured side is rotated outward ; occasionally, it is rotated inward, while the uninjured knee is somewhat flexed. The muscles of the lumbar region and of the buttocks, also the iliopsoas, tensor vaginae femoris, rectus, and sartorius, undergo more or less atrophy, and the affected thigh can not be flexed so vigorously as the normal one. The pelvis is sensitive to pressure, both anteriorly and posteriorly, on the injured side, and the relation between the sacrum and ilium on that side is more or less changed from the normal.

The depression of the pelvis and the other signs of displacement are likely to be more marked in proportion to the extent of the fracture, or to the degree of violence that caused it ; this is, however, not at all necessarily the case. The symptoms of displacement previously described may also be observed after fracture of the hori-

zontal or descending ramus of the pubes, and, in addition, the adduction of the thigh is more or less restricted.

Fractures of the ischium usually leave the bone noticeably thickened, and the patient is unable to assume a sitting posture for a long time afterward. In these cases, too, the muscles of the buttocks and thigh undergo atrophy.

Fractures involving the acetabulum lead to impaired mobility of the hip-joint, and not infrequently to complete ankylosis. The latter is especially likely to follow when the head of the femur is driven directly into the acetabulum by a force acting from the side, fracturing the acetabulum on its inner aspect, or when the acetabulum is involved in an extensive comminuted fracture.

Fractures of the pelvis occasionally occur as a result of comparatively slight degrees of violence. Richter, for instance, has reported a case of fracture of the pelvic rim and displacement of the sacro-iliac articulation due to a fall from a comparatively trifling height.

The **prognosis** as to function is most unfavorable in cases of fracture of the acetabulum, because of the subsequent ankylosis or of the condition of recurrent dislocation of the joint, which is a frequent sequel (insurance allowance, $33\frac{1}{3}\%$ to 75%). There are, however, exceptions to this rule, as is shown by the cases cited further on.

Complications, in the shape of injuries of the bladder and urethra, are also likely to produce very troublesome sequels.

Fractures of the iliac bones cause, as a rule, the least functional disability.

Average insurance allowance, from 0 to 20% .

Fractures of the Sacrum.

Fractures of the sacrum occur in consequence of such accidents as being caught under heavy weights or being run over, or they are indirectly caused by a fall on the

buttocks. These fractures are very often seen in connection with fractures of the pelvis.

The **symptoms** consist in pain, radiating toward the pelvis and thighs, and in difficulty in walking and stooping. If the fracture is complicated by injury of the sacral cord, the sacral nerves, or the cauda equina, we have to deal also with both motor and sensory paralysis of certain muscles of the outer side of the foot, with paralysis of bladder and rectum, and with neuralgic pains radiating toward the thighs.

Case of fracture of the left acetabulum resulting in slight functional disability.

A hod-carrier, thirty-two years of age, fell with a scaffolding from a height of about nine feet on October 19, 1890. He was treated for a time in the hospital. From January 19 until March 15, 1891, he attended my clinic. He was of medium size; he walked with a limp and required a cane. The pelvis was asymmetric and was depressed on the left side. The mobility of the hip-joint was restricted, and the left lower extremity appeared shortened and wasted.

When discharged, the movements of the hip-joint had become almost normal; there was still slight crepitation on movement, and the circumference of the left thigh measured two centimeters less, and the left calf, one centimeter less than the corresponding part on the opposite side.

Insurance allowance, 20%. The skiagraph showed a well-marked fracture of the acetabulum and considerable narrowing of the left side of the true pelvis.

Case of fracture of the left ilium.

A carpenter, forty years of age, fell from a roof nine feet high on October 24, 1894, striking on the left hip and on the left side of the head. He was treated in the hospital until January 13, 1895, and subsequently at home by the physician of his trade-union.

I examined him on October 21, 1895. He was a rather large man, somewhat thin, and a very heavy drinker. When he lay on the back, the left side of the pelvis was higher than that of the right side, and the left leg appeared shortened. Careful measurement, however, showed the length of both extremities to be the same; the left thigh was rotated outward. The left side of the pelvis was narrowed, the left anterior superior spine being placed $2\frac{1}{4}$ cm. nearer the median line than the right. The left pubic bone, near the symphysis, was distinctly thickened. Movement of the hip-joint was only slightly affected, but gave rise to pain. The whole extremity was greatly atrophied, and dragged in walking.

The patient was first conceded an insurance allowance of $33\frac{1}{3}\%$, which was later reduced to 20%. In the course of time sequels of the injury to the head, in the form of hysteric convulsions, caused the

allowance to be raised to 75%. No improvement has taken place thus far.

Case of fracture of the left ilium, left ascending ramus of the ischium, and tuberosity of the ischium; also crushing of the left side of the abdomen and testicles and double fracture of the left femur.

A mason, thirty years of age, was standing on a staircase, which gave way, causing him to fall with it a distance of two and a half stories. He sustained the injuries just mentioned, and was treated in the hospital. The accident occurred in November, 1886. I examined him on May 2, 1890. He was a man of middle height, rather pale and thin. He walked with difficulty and with the aid of crutches. The left lower extremity was much shortened; it did not touch the ground when the patient stood upright. When he lay on the back, the left side of the pelvis was seen to be higher than the right. The whole pelvis was deformed; the tuberosity of the left ischium was greatly thickened, being nearly the size of a child's fist. A point of callous thickening could also be felt on the ascending ramus of the left ischium. The muscles of the buttocks on the left side were greatly atrophied and very flabby, so that the bone could be distinctly felt; the patient was obliged to use a rubber cushion in order to endure a sitting posture. The circumference of the middle of the left thigh was diminished by four centimeters, and the left sciatic nerve was exceedingly sensitive. The patellar reflex was exaggerated on that side.

The patient received 100% insurance allowance; the fractures of the femur had reunited very unfavorably, and he was unable to work, either standing or sitting.

Case of dislocation of the right hip-joint and fracture of the right ascending ramus of the ischium. Sequel, good recovery.

A hod-carrier, fifty-four years of age, fell from a height of one story on March 23, 1893. He was treated in the hospital for seventeen days; subsequently at his own home.

I examined him on April 10, 1895. The right lower extremity was very slightly shortened, the muscles of the right thigh were atrophied, and the mobility of the right hip-joint was slightly impaired. The thickening and displacement of the bone at the point of fracture of the ascending ramus of the right ischium were distinctly perceptible. The patient at first walked with a limp and with the assistance of a cane; I happened, however, one day to see him running up a hill without any difficulty.

He received no allowance for the injury to the pelvis, but was conceded 25% for other injuries.

Case of fracture of the left side of the pelvis (ilium and acetabulum). Sequel, recurrent dislocation of the left hip-joint.

A mason fell from a ladder on June 8, 1897, sustaining, among others, the foregoing injuries. He was treated at home, where he lay in bed for eleven weeks. On October 8, 1897, he entered my hospital for treatment. He was a large and very vigorous man. The left shoulder-joint was ankylosed and the muscles of the left arm were atrophied. On the left side of the chest the pleura was thickened. The pelvis was asymmetric; the left side was raised above the

right when the patient lay on the back; the left lower extremity appeared shortened, and was rotated outward. Points of thickening could be felt on the ascending ramus of the left ischium. Flexion of the hip-joint could be carried to an angle of 120 degrees; the total range of flexion and extension equaled 66 degrees, and all movement of the hip-joint was painful. The left lower extremity was atrophied to an extent of two centimeters. The head of the femur slipped out of the acetabulum whenever the patient moved at all carelessly, or even when, in response to the application of electricity, the muscles of the thigh or buttocks contracted violently. By the aid of a support which retained the head of the femur in position the patient was enabled to walk very well without a cane. The ankylosis of the shoulder having been overcome, he was discharged, with an insurance allowance of 60%.

Dislocations of the Pelvic Bones.

Dislocations of the pelvic bones are a very rare form of injury; unless properly reduced, they give rise to marked symptoms.

The displacement, when one side of the pelvis is involved, is very noticeable; the position of the pelvis and of the lower extremity is different on the two sides, and is manifested also in the gait. Pain and atrophy of the muscles are prominent symptoms.

The capacity for self-support is, as a rule, greatly diminished.

Dislocations of the Sacrum.

This lesion is usually seen in the form of a subluxation, the sacrum being displaced forward. The **symptoms** are a constrained position of the body, lordosis and scoliosis of the lumbar region, pain in the lumbar region, and restricted mobility of the spine and lower extremities. Externally, there is a distinct depression of the area normally filled out by the sacrum. In addition, the muscles of the thigh and buttocks show signs of atrophy.

2. INJURIES AND TRAUMATIC DISEASES OF THE HIP-JOINT.

(104 Cases.)

Contusions and Sprains of the Hip-joint.

Contusions and sprains of the hip-joint are caused by falls on the hip, on the great trochanter, by blows or kicks, or they may be due to the hip being caught and compressed between two objects or under falling walls, etc. The lesion in many cases is soon followed by complete recovery. Sometimes the hip is slightly painful, and the muscles of the hip and thigh remain atrophied for a time.

In light cases the patient is but slightly incapacitated for work; the insurance allowance varies from 0 to 20%, exceeding this figure in more severe cases.

Inflammation of the Intertrochanteric Bursa.

This lesion is observed in cases of severe contusion of the hip. The **symptoms** consist in pain and swelling, restricted mobility of the hip-joint, and difficulty in walking; later on, in crepitating sounds. The muscles of the hip and thigh usually undergo atrophy.

The insurance allowance, after subsidence of the acute inflammation, varies from 0 to 20%.

Simple Uncomplicated Sprains of the Hip-joint.

This form of injury, caused by sudden strains, is seldom met with, except in the building trades, where it occurs with relative frequency. It is produced by a misstep in crossing an open space, or in mounting or descending ladders and stairways; a frequent cause is slipping while carrying a heavy burden or when pushing a wheel-barrow, etc. The injury leads to pain on movement of the hip-joint and to slight atrophy of the muscles of the hip and thigh. In the cases that I have seen the patients were, as a rule, able to resume work in from four to six weeks.

Dislocation of the Hip-joint.

This is one of the rarer forms of injury. It is seen in individuals who have been run over, caught under falling walls, etc., or who have fallen from a height, and is always caused by indirect violence acting on the trunk or thigh.

The **symptoms** with which we subsequently have to deal in cases in which reduction is practised are as follows :

The thigh is slightly rotated outward or inward, in consequence of cicatricial contraction of the capsule, the direction of rotation and its degree depending on the location and extent of the laceration. The muscles in connection with the hip-joint—those of the buttocks, of the thighs, and, to a certain extent, those of the leg—appear atonic and atrophied. The movements of the affected thigh lack the strength of those of the opposite side, and frequently produce distinct crepitation. The weakness of the limb is very noticeable for the first few weeks, and the patient often walks with a limp.

If the dislocation is complicated by injuries of the nerves, recovery from the muscular atrophy will be proportionately delayed. In cases of backward dislocation the sciatic nerve is always badly contused, stretched, or strained, if not even more seriously injured.

The functional disability is greatly increased if, as happens in very rare instances, the iliofemoral ligament is involved in the laceration of the capsule.

We sometimes have to deal with a very serious complication in the shape of a fracture of the neck of the femur, occurring at the time of dislocation, or possibly during reduction. The functional prognosis is thereby made very grave, as the limb may be rendered useless for a long time, if not permanently.

The **treatment** consists of medicomechanical exercises, accompanied by massage, baths, and electricity, with

the aim of overcoming the ankylosis and muscular atrophy.

In respect to the duration of treatment, from four to six weeks are usually required for uncomplicated cases, and a proportionately longer period when complications exist.

The patient, since he can usually walk fairly well, is, as a rule, not greatly incapacitated for work. An insurance allowance of 25 % is usually sufficient.

Case of dislocation of the left hip-joint, followed by considerable functional disability at first; later, by marked improvement.

A coachman, on May 31, 1897, was caught under a pile of flour-bags, which fell on him, causing, among other injuries, a dislocation of the left hip-joint. He was treated in the hospital for nine and a half weeks, seven of which he spent in bed. Subsequently he attended a clinic, where he was treated by massage and electricity. He received a course of treatment in my hospital lasting from April 17 until July 10, 1899, after which date he attended my clinic until September 16, 1899, when he was finally discharged. He was treated chiefly for a subluxation of the right acromioclavicular joint.

Symptoms.—Pain in the left hip-joint, especially on climbing stairs. The left hip appeared somewhat atrophied when compared with the right, as did also the muscles of the thigh. Flexion of the hip-joint on the left side was somewhat restricted; with the patient lying on the back, the thigh could be flexed to an angle of 40 degrees on the left side and 55 degrees on the right side; when standing upright, the angle between the thigh and the trunk, when the former was flexed, equaled only 130 degrees on the left side in comparison with 90 degrees on the right side.

When the patient resumed work, there remained only a slight impairment of mobility of the left hip-joint.

Case of chronic synovitis of the left hip-joint following an accident caused by a caving-in.

A mason, twenty-three years of age, was caught in the caving-in of an embankment on May 20, 1897. He was at first treated at his home; on August 23, 1897, he began a course of treatment in my clinic. The patient was a small but vigorous man. His right lower extremity was held flexed and was almost completely ankylosed at both hip-joint and knee-joint. The muscles of the limb were greatly atrophied and displayed marked contractures. Every effort at movement caused pain. The thigh formed an angle of 125 degrees with the trunk; the knee was fixed at an angle of 150 degrees. The patient was first treated by an extension apparatus, and subsequently by exercises, massage, electricity, and baths. Later on, he received a supporting apparatus, which he still uses in walking. Without its aid he can walk only with difficulty and by leaning on two canes. When dis-

charged, the mobility of the hip-joint and of the knee-joint had considerably improved, and the limb was held less flexed than before. Insurance allowance, 75%

Traumatic Coxitis.

The **symptoms** of this disorder, which is met with in consequence of contusions, falls, or kicks on the hip, or when the parts are crushed by more serious accidents, are almost identical with the symptoms of nontraumatic inflammation of a similar nature. Thiem asserts, however, that the traumatic form is more likely to lead to ankylosis. Suppuration never occurs in these cases. Other symptoms are: flexed position of the hip-joint and knee-joint; apparent shortening of the limb; pain in the hip-joint; atrophy of the muscles of the whole limb, especially of those of the hip and thigh; difficulty in walking; and a limping gait.

Treatment.—The same as of the nontraumatic form.

Insurance allowance, from 60% to 80% if there is marked difficulty in walking; from 40% to 60% in less severe cases. If the patient is able to walk without a cane, 20% is sufficient.

Tubercular inflammation of the hip-joint may be excited by traumatism in individuals in whom tuberculosis already exists in latent form. It may be manifested primarily in the hip-joint or may appear there in consequence of metastasis. Suppuration frequently sets in and the joint may be in large part destroyed. The course of recovery is exceedingly protracted.

3. INJURIES AND TRAUMATIC DISEASES OF THE THIGH.

Injuries of the Thigh Due to Contusions.

(Ninety Cases, Including Wounds.)

Simple contusions of the thigh due to kicks, falls, and the like usually heal in a short time. A long course of

treatment, on the other hand, is required for severe cases of crushing, caused by being run over, caught under heavy falling objects, etc. The hemorrhagic extravasations thus occasioned are slowly absorbed, and the injury is followed by atrophy of the muscles, especially marked in the case of the quadriceps extensor, which is frequently very resistant to treatment.

Recovery may not take place under from four to eight weeks, or even longer. In one case under my care the patient was not able to resume work, even to a limited extent, for two years. The cause of the persistent disability often lies in lesions of the vessels and nerves and in subcutaneous rupture of the muscles.

Malignant tumors occasionally develop as a sequel to severe contusions of the thigh.

The accompanying skiagraph (Fig. 63, p. 369) shows a sarcoma of the right femur. The patient was a workman, twenty-two years of age, who had fallen from a scaffolding into a cellar from a height of about six feet. He fell on his right thigh, which struck against a beam. He continually complained of pain in the thigh, which, however, never became very severe. The enlargement of the thigh—which, on palpation, was found to be due to a hard tumor adherent to the bone—was distinctly visible when viewed from the extensor surface. A skiagraph taken four weeks after the accident was indistinct; the one here reproduced was taken four weeks later. Meanwhile the patient was declared by the authorities to be unfit for military service. When requested by his trade-union to submit to an operation, he withdrew himself from our observation.

Subcutaneous Rupture of the Muscles.

This lesion as it occurs in the thigh is observed chiefly in the extensor muscles, and of these the rectus is practically always the one involved. The rupture occurs under the same conditions as those which produce the fractures of the patella due to muscular violence. The latter lesion, in the form of a transverse fracture in the middle of the bone, occurs much more frequently than the former. Twenty of these indirect fractures of the patella have occurred in my practice, while I have had to deal with only five cases of rupture of the rectus.

PLATE 31.

Subcutaneous Rupture of the Semitendinosus.

A workman, forty-four years of age, slipped from a beam on September 11, 1896, and immediately felt a pain in the left thigh posteriorly. When I examined him, on December 3, 1896, I found the muscles of the left thigh in the condition here depicted. There was a rather long tumor-like mass in the line of the lower part of the semitendinosus; the muscles of the thigh were all slightly atrophied and the patient could not flex the left knee as vigorously as the right. The circumference of the left thigh was two centimeters less than that of the right. The patient complained more of weakness than of pain. He was treated for nearly four months by massage, exercises, and static electricity. Insurance allowance, 15%, which he still receives.

Remote Symptoms.—A depression at the point of rupture, marked atrophy of the rectus or quadriceps extensor, secondary atrophy of the flexors and of the muscles of the leg, inability to extend the leg, and difficulty in walking.

A hod-carrier, forty-five years of age, a very large and unusually powerful man, when placing his right foot on one of the lower rungs of a ladder which he was descending, slipped in a way to cause the knee to be suddenly flexed, while, at the same time, he threw his body backward to save himself from falling. He immediately felt a violent pain in the lower third of the right thigh anteriorly, and was unable to bear his weight on that leg. The accident occurred on October 20, 1890. When I examined him, on January 17, 1891, I found a distinct gap in the rectus muscle, in the lower third of the thigh, a full hand's-breadth above the patella. The gap admitted two fingers. All the extensor muscles had lost tone and were greatly atrophied, as were also the flexors. The patient was unable to extend the knee, and the leg dragged in walking. For several months he was obliged to use two crutches in walking; later, he used two canes; and still later, only one cane.

After a course of treatment of massage and electricity lasting thirteen months the patient was discharged, wearing a knee-cap. He received 60% insurance allowance, which, in November, 1895, was reduced to 40%, and at the beginning of 1897 was further reduced to 20%. Since then he has completely recovered.

Wounds and Scars of the Thigh.

Of the various wounds of the thigh those which we need most to consider here are the infected wounds, which







Fig. 63.

are followed by extensive suppuration, necessitating deep incisions. The scars that result in these cases are likely to interfere very seriously with the movements of the hip or knee, according to their location. Walking is in many cases very difficult for a long time afterward. Cellulitis affects the lower extremity, however, much less frequently than the upper.

The more deeply the scar is attached, and the nearer it lies to the knee, the greater is the loss of functional power. Compound fractures necessitating operative measures are sometimes followed by scars, which, by reason of their attachments to the bone, have an exceedingly unfavorable effect on the action of the limb. Some patients, on the other hand, particularly youthful ones, suffer no inconvenience from the presence of the scars. It often requires a long time, perhaps years, for the scars to free themselves from their deep attachments and to become superficial.

Treatment by massage (stretching), exercises on an apparatus, galvanism, wet compresses, and warm baths are effective in improving the condition of the scars.

The insurance allowance is proportionate to the functional disability.

Fractures of the Femur.

(148 Cases, Including Fractures of the Neck.)

Considerations on Anatomy and Function.—The weight of the body is transmitted to the head of the femur as it rests in the cavity of the acetabulum. The neck of the bone forms an obtuse angle with the shaft, the angle varying in different individuals. The ordinary angle is about 140 degrees, but in a number of bones I have found it to equal only 125 degrees. Below, where the neck unites with the shaft, the angle is more obtuse than above, where it approaches a right angle. The neck is also considerably broader below than above, where, near the head of the bone, it becomes quite slender.

The great carrying power of the neck of the femur is explained by the internal structure of the neck and head of the bone, in which the mathematical laws upon which its strength is based are clearly displayed. The neck is constructed to resist lateral as well as vertical pressure, and the arrangement of the cancellous tissue accords with this. Firmness and elasticity are mingled in the structure of both the

neck and head of the bone. When the limits of its elasticity are exceeded, fracture of the neck of the femur is the inevitable result.

Fractures of the Head of the Femur.

This is a very unusual accident, and occurs only as the result of severe direct violence, such as being run over, and is then associated with a fracture of the pelvis. In the most favorable cases we must anticipate an ankylosis of the hip-joint.

Fractures of the Neck of the Femur.

(Thirty-eight Cases.)

The neck of the femur may be fractured by a force acting perpendicularly to the bone, such as a fall on the knee, or by one acting transversely, such as a fall on the hip, more especially on the great trochanter. The fracture may also be caused by tension of the iliofemoral ligament when the hip is overextended. Old persons are most subject to the injury. By reason of the porosity and lessened elasticity of the bones in old age, the fracture sometimes occurs in consequence of a very slight accident. But even in strong young men, showing no signs of syphilis, tuberculosis, or rachitis, a trivial cause may, under certain conditions, suffice to produce the lesion in question. I have collected six cases, some of which concern very young and extremely vigorous hod-carriers, and in all of which the fracture was caused by a misstep or awkward movement when carrying a heavy load on the shoulder. The lesion in all cases was very severe, and functional power was greatly impaired. (See Part I, Fractures Incidental to Special Work, p. 66.)

The fractures due to tension of the iliofemoral ligament when the hip-joint is overextended have already been referred to.

The more trivial the accident, the more likely is the fracture to be overlooked; the injury is diagnosed as a contusion or sprain of the hip-joint, and is treated by compresses, inunctions, hot baths, and massage. Further

PLATE 32.

Showing the Scars in a Case of Compound Fracture of the Right Femur and Ilium, and Loss of the Left Testicle, with Excellent Recovery.

A paper-hanger, twenty-one years of age, fell from a fourth-story window on August 9, 1894, on to a sharp-pointed iron railing, where he was held fast until, after an hour's delay, the iron bars were filed through. He was removed to a hospital, where he remained until December 10, 1894. Subsequently he came under my care, and was discharged in August, 1895, with an insurance allowance of 25%, which was discontinued a few months later, the patient having fully recovered, and being able to work as well as before the accident.

harm is not infrequently done by advising the patient to begin to walk very soon.

A differential diagnosis as to intracapsular and extracapsular fracture, or median and lateral fracture (Helferich), is of great practical importance, since bony union very rarely takes place after an intracapsular (impacted) fracture, fibrous union, or pseudo-arthritis, being the rule in these cases. The working capacity is greatly diminished.

Symptoms of intracapsular fracture subsequent to healing are as follows: The patient is almost always obliged to use a cane or a supporting apparatus in walking; the limb always appears shortened, and is frequently rotated slightly outward; less frequently, rotated inward. The whole limb, from the buttocks to the sole of the foot, shows signs of atrophy. The rounding of the hip over the trochanter is frequently found to have disappeared, owing to atrophy of the *glutens medius*. Even the foot may appear smaller, and the sole of the foot is always flabby. The knee is held flexed. At the hip-joint the mobility is not, as a rule, greatly affected, adhesions and ankylosis not being common to this form of fracture. Patients frequently complain of feeling as if there were a spring in the hip-joint. X-rays show the neck of the femur to have disappeared, the trochanter lying quite near



Fig. 1



Fig. 1^a



the acetabulum (impacted fracture). In other cases we find the neck shortened and separated from both the head and the trochanter.

The external appearances in cases of extracapsular fracture of the neck of the femur (lateral fractures of Helferich), in which the line of fracture approaches the trochanters, are frequently quite similar to the foregoing; an essential practical difference, however, lies in the fact that extracapsular fractures usually form a bony union, the growth of callus being, as a rule, exceedingly well marked. The angle between the shaft and the neck is usually decreased, approaching a right angle, and causing the limb to appear shortened in these cases also; the great trochanter is rotated outward and is very prominent. As seen in a skiagraph, it lies further from the acetabulum than on the normal side. The apex of the trochanter is more or less elevated above the Roser-Nélaton line, the degree to which the limb is shortened depending on this point. The mobility of the hip-joint is usually restricted; the knee is held flexed; and the whole limb, including the foot, is atrophied. Patients usually walk with a limp. The working capacity of the patient, although greatly diminished, is usually less seriously affected than in case of intracapsular fractures in which bony union does not take place.

Another important point of difference between the two forms of fracture deserves special attention by reason of its practical bearing. The fragments in cases of impacted intracapsular fractures, although to all appearances firmly fixed, are quite likely to become separated from time to time. This does not occur in cases of extracapsular fracture after union is once established.

While, as a rule, in extracapsular fractures the neck becomes united to the shaft at a less obtuse angle than normal, thereby depressing the pelvis on the affected side and causing an apparent shortening of the limb, the opposite occurs in rare instances: the angle is widened, the

pelvis is raised on the affected side, and the extremity appears longer than normal, necessitating flexion of the knee in the upright position. The trochanter is brought perceptibly nearer to the acetabulum, and, as usual, the muscles are atrophied.

In some cases the original injury consists of a fissure in the bone. The injured individual is conscious of pain in the hip, and rests at home for a few days, the fracture proper occurring when he again attempts to work. In other instances definite fracture does not take place until a considerable period has elapsed, during which the patient has used the leg as usual. It is probable that incomplete fractures of this kind are never diagnosed in time; the patient is treated for a contusion of the hip or similar injury, the limb is not found shortened at first, and a fracture is distinctly excluded until, after a time, a very perceptible degree of shortening is discovered. These cases are met with from time to time in accident-practice, and in respect to indemnity, are very important.

It remains only to speak of the effect on functional power of the different forms of fracture of the neck of the femur. It is hardly necessary to state that functional power is permanently impaired in cases of ununited intracapsular fracture. The chief cause of the loss of power lies in the presence of the unhealed fracture itself; in addition, there is atrophy of the muscles of the hip and of those of the extremity. Even in these cases, however, we meet with exceptions.

Functional power is also impaired after consolidation of extracapsular fractures; the shortening of the extremity causes lameness, which, because of the abnormal position of the head of the bone in the acetabulum, and the weakness of the joint, is not to be overcome by the use of a thick-soled shoe.

The following muscles undergo primary atrophy: the glutei, the iliopsoas, the piriformis, and the obturators. Secondly, the other muscles of the limb become in-

volved, especially those of the thigh. If the fracture heals advantageously and the functional power of the part is satisfactorily restored, the condition of the muscles will improve proportionately; otherwise, if union does not take place, they usually remain permanently atrophied. In the majority of cases, however, some improvement of functional power may be expected in the course of one or two years, even in elderly persons.

Case of impacted fracture of the neck of the left femur, followed by non-union.

A workman, forty-seven years of age, fell down-stairs on September 3, 1898, sustaining a fracture of the neck of the left femur. He was treated in the hospital up to November 14th, and subsequently attended my clinic. He was a thick-set man of middle height. He walked with a limp and with the aid of two canes. The middle of the lower extremity was quite edematous. The circumference of the thigh was two centimeters less than that of the opposite side. The patient said that in walking he felt as if there were a spring in his hip.

The skiagraph showed an ununited fracture of the neck of the femur—apparently an intracapsular fracture.

When discharged, the circumference of the left thigh exceeded that of the right thigh by two centimeters; the foot, however, had become decidedly atrophied. There was slight edema of both limbs, more noticeable in the left one. Movement produced cracking sounds in the left hip-joint. Flexion was somewhat restricted on the left side.

Insurance allowance, 66 $\frac{2}{3}$ %.

Case of fracture of the left femur caused by overextension of the thigh when placing a heavy windlass on the shoulder. Sequel, good recovery.

A carpenter, thirty-seven years of age, in placing a heavy windlass on his shoulder, on September 21, 1891, caused an overextension of the left hip-joint. He felt a sudden violent pain and as if something had cracked, like a stick breaking. He fell to the ground, and had to be carried home. He was treated for several weeks for a "sprain of the hip." He then attempted to work, but was unable to continue.

I examined him on November 15, 1893. He was a rather large, vigorous man; the left leg was slightly shortened and slightly rotated outward; the muscles of the left thigh were atrophied to a moderate degree. He was only slightly lame. A diagnosis of fracture was not made at this time. He was soon discharged from clinical treatment, but returned on December 10, 1894. The muscular atrophy, pain, and lameness had increased. A diagnosis was made of fracture of the neck of the femur; the patient was put to bed and treated by massage and electricity. He was discharged with an insurance allowance of 15%.

Case of fracture of the neck of the left femur caused by turning the left knee and overextending the hip-joint.

A workman, thirty-three years of age, wishing to take something out of a drawer that was placed high up in the wall, mounted on an

inverted pail. The pail began to rock and the man fell so that his right foot slipped outward and his left hand struck against the wall. He immediately felt a violent pain in the left hip, and was unable to walk. In the hospital to which he was taken he was treated for a sprain of the hip-joint.

On September 1, 1897, he entered my hospital for a course of after-treatment. He was a fairly large, vigorous man; he walked with a limp and used a cane. The left lower extremity was greatly atrophied, especially in the thigh, and was slightly rotated outward. The limb felt somewhat cold. The left thigh measured full $4\frac{1}{2}$ cm. less than the right; the left leg 3 cm. less than the right. Active movement in the thigh was limited and painful. Passive movements were less affected. There was no crepitation. Treatment by massage and electricity proved only slightly beneficial.

The skiagraph showed an impacted fracture of the neck of the femur. The neck of the bone had almost disappeared and the head and neck of the bone were separated by an almost vertical, light line; the great trochanter was raised somewhat above the level of the head. The patient was discharged on December 11, 1897, with an insurance allowance of 66 $\frac{2}{3}$ %. An examination made on January 18, 1899, showed no improvement; on the contrary, the muscular atrophy had increased; the circumference of the thigh measured fully 5 cm. less than that of the opposite side. There was crepitation on movement of the hip-joint, and the patient still walked with a cane.

Case of ununited intracapsular fracture of the neck of the left femur. Sequel, pseudo-arthritis.

A workman, thirty-eight years of age, slipped on an asphalt walk, falling over backward. He was treated for nine weeks in a surgical institute for a fracture of the neck of the left femur. An extension apparatus was employed for three weeks; mud compresses were then applied, and, finally, the treatment consisted simply of rest in bed.

I examined the patient and took a skiagraph of him on February 16, 1897. He was a tall, thin man; in walking he used two canes, and the left leg dragged. The latter was greatly atrophied and much shortened; it was also rotated outward, and could be only a little raised from the ground. When the patient was lying down, the great trochanter could be moved back and forth. A skiagraph showed the trochanter to lie considerably above the head of the bone; the neck was greatly shortened, and was divided into two parts by a light line of fracture about five millimeters in width.

The patient received 100% insurance allowance.

Case of fracture of the neck of the left femur caused by a trivial accident when carrying a hodful of stones (fracture incidental to special work).

A hod-carrier, forty years of age, a very vigorous and perfectly healthy man, was injured on August 1, 1889, by a stone which fell from the fourth story of a building and which, in rebounding, grazed his left hip. He immediately felt a violent pain in the left hip-joint, accompanied by a grinding sensation, and was unable to stand on the left leg. He carefully put down the hodful of stones, and was carried to a hospital by his comrades, where he remained for about two months.

He was treated by me clinically from October 31, 1889, until March 20, 1891. He was a vigorous, stout man; he walked with a crutch and a cane. The left lower extremity was much shortened and atrophied, and was rotated outward. The head of the femur did not seem to lie entirely in the acetabulum. The mobility of the hip-joint was somewhat restricted. The middle of the thigh measured $11\frac{1}{2}$ cm. less in circumference than the opposite side, even so long as seven years after the accident. A skiagraph showed an intracapsular fracture; the trochanters lay very close to the acetabulum, and the apex of the great trochanter was raised above the head of the bone. Insurance allowance, 75%, at which figure it has remained.

Another case concerned a hod-carrier, thirty-two years of age, who had always been perfectly strong and healthy; he sustained a fracture of the neck of the right femur in stepping from a ladder to a scaffolding with a load on his shoulder. He said that he felt as if the scaffolding was giving way under his foot. Union was accompanied by a marked degree of shortening and by forward displacement of the peripheral fragment, which appeared as a large tumor in the right inguinal region. There was, in addition, a marked degree of outward rotation. The mobility of the hip-joint was restricted, the muscles were atrophied, and the patient walked with a limp. Insurance allowance, 50% (fracture incidental to special work).

Case of fracture of the neck of the right femur caused by a trivial accident when carrying stones (fracture incidental to special work).

A workman, fifty-one years of age, who had always been in good health, slipped with the right foot from the plank on which he was walking when carrying a hodful of stones, giving his hip an outward wrench. He was at first treated at home by innunctions; three weeks later he was removed to a surgical institute. An extension apparatus was applied for eight days, followed by massage and baths. He was discharged after five weeks' treatment, and was subsequently given massage at home.

The accident occurred on November 12, 1893. I examined him on July 23, 1899. The skiagraph then taken showed an ununited intracapsular fracture of the neck of the right femur.

Fractures of the Femur in the Region of the Trochanters.

These fractures are caused by direct violence, in the shape of a fall on the great trochanter, and are often connected with fractures of the neck or with infratrochanteric fractures.

In cases of transverse or oblique fractures of the great trochanter the trochanter is drawn upward by the gluteus medius and minimus, the pyriformis, and the quadratus femoris, probably by the first two chiefly, so that its apex is approximated in the pelvis. The muscles in question

remain atrophied for a long time, and the movements that they control—namely, abduction and inward and outward rotation—are restricted and weakened.

An infratrochanteric fracture necessarily leads to shortening of the bone; hence with this lesion we always find an atrophy of the muscles of the thigh, and, secondarily, of the leg and foot as well. The upper fragment is drawn upward by the muscles inserted into the great trochanter. The remote symptoms of this fracture are: shortening, atrophy of the muscles of the whole limb, including the foot, growth of adhesions in the hip-joint and impaired mobility, pain in the joint, cracking sounds on movement, and lameness.

Insurance allowance, as a rule, 50%.

Case of fracture of the right femur in the region of the trochanters. Sequel, an extreme degree of shortening.

A carpenter, forty-two years of age, fell from a scaffolding two stories high, on August 26, 1889, striking his right hip on a beam lying below. He was treated in the hospital for thirteen weeks. I examined him on January 2, 1890. He was a tall, rather slender, and thin man, and was extremely deaf. He could walk with difficulty by the aid of a cane and a crutch. The right lower extremity was shortened to a striking degree, and was greatly atrophied. The great trochanter was exceedingly prominent. Movement of the right hip-joint was restricted.

A skiagraph, taken early in 1898, showed a peculiar condition, the line of fracture passing between the trochanters and running outward into a very sharp-pointed, sickle-shaped notch about twelve centimeters in length. The shaft of the femur was impacted in the neck of the bone, and the apex of the great trochanter lay close to the pelvic bone, probably being drawn upward by the muscles of the buttocks. The total insurance allowance, based on the condition here described, and on the deafness, which was due to a fracture of the skull, equaled 80%.

In another case, one of double fracture of the right femur, in which one of the fractures involved the bone just below the trochanters, the skiagraph also showed a very peculiar displacement of the fragments. In uniting, a coxa vara was formed, the limb being slightly shortened. Five months after injury 33½% insurance allowance was conceded.

Fractures of the upper third of the femur almost invariably lead to shortening and to extensive formation of callus. In addition, we find a lateral displacement,

with more or less well-marked outward or inward rotation, in proportion to the effect of the violence. The hip-joint assumes a position of valgus or varus (*coxa valga* or *coxa vara*). The consequent abnormal position of the head of the femur in the joint can be easily seen by means of an X-ray examination.

Both forms of displacement of the hip-joint induce secondary displacement of the knee-joint; *coxa vara* being, as a rule, accompanied by a *genu varum* and *coxa valga* by a *genu valgum*. Inward or outward rotation of the foot and *pes varus* or *valgus* are further sequels.

Adhesions are apt to be formed in the hip-joint, and the muscles of the whole limb are invariably atrophied. Pain on movement of the hip joint and lameness necessitating the use of a cane, often persist for a long time. Other associated displacements of the knee-joints will be discussed later on.

Treatment.—Since functional disorders of the limb, especially of the hip-joint, are prominent in all these fractures, a vigorous effort should be made to relieve them or to make them disappear altogether. Supporting apparatus, mechanical exercises, passive movement, massage, baths, etc., are all included in our therapeutic material.

It is especially advisable for the patient to wear a supporting apparatus, preferably the Hessing-Schlenkhülsen, as recovery is greatly hastened thereby. For an impacted fracture of the neck of the femur, for instance, a supporting apparatus is especially indicated in order to prevent displacement of the fragments. When the limb is only slightly shortened, it often suffices for the patient to wear a laced shoe with a raised sole. This, however, does not apply to cases accompanied by great weakness of the hip-joint.

Systematic massage of the atrophied muscles should not be neglected. As a rule, the supporting apparatus can be discarded at the end of a few months, though it is often

difficult to persuade the patient to do so ; he is then inclined to adopt a crutch, especially if much shortening exists. The insurance allowance is usually quite high in all these cases, from 50 % to 66 $\frac{2}{3}$ % being the ordinary rate.

Case of comminuted fracture of the right femur. Sequels : marked degree of shortening ; deep scars, adherent to the bone ; and stiffness of the limb.

A workman, fifty-five years of age, was struck in the right thigh by a piece of wood on January 19, 1887. His right ankle was caused to turn outward and he was thrown to the ground. He sustained a comminuted fracture of the right thigh and a fracture of both malleoli. He was treated in the hospital for about three months. I examined him on October 21, 1887. The right lower extremity was shortened and swollen, and almost absolutely stiff at the knee and ankle. He could walk with difficulty, leaning on two crutches. On November 4, 1887, he was suddenly seized by fever and chills, with signs of inflammation of the thigh, which became greatly swollen. He was in the hospital until June 22, 1888. Deep incisions were made on the extensor surface of the thigh, and pus and splinters of bone were removed. I examined the patient again on June 24, 1888, and treated him in my clinic until the end of April, 1889. The right lower extremity was strikingly shortened, being about six centimeters shorter than the left. He complained of pain throughout the limb and of numbness of the foot. He was unable to walk or to sit for any length of time, and standing was still more difficult. On the anterior surface of the thigh there was a long scar, reaching almost from the inguinal fold to near the knee ; it was adherent to the bone throughout. The thigh and leg were edematous, and the whole limb was atrophied. The mobility of the hip-joint and of the ankle-joint was limited, and the knee-joint was completely ankylosed. The right ankle was much thickened and deformed. The patient walked with the aid of a crutch and a cane. He then received 100 % insurance allowance. An examination on February 17, 1894, showed considerable improvement in respect to mobility of the hip-joint and knee-joint, and the scar was considerably less adherent. Insurance allowance, 33 $\frac{1}{3}$ %.

Fractures of the femur in its upper half present a very characteristic picture after union is established.

The **symptoms** are as follows : shortening of the limb, especially of the thigh ; a well-marked callous thickening at the point of fracture ; displacement of the fragments, which are usually bent with the convexity directed outward ; genu varum or valgum ; outward or inward rotation ; atrophy ; and lameness.

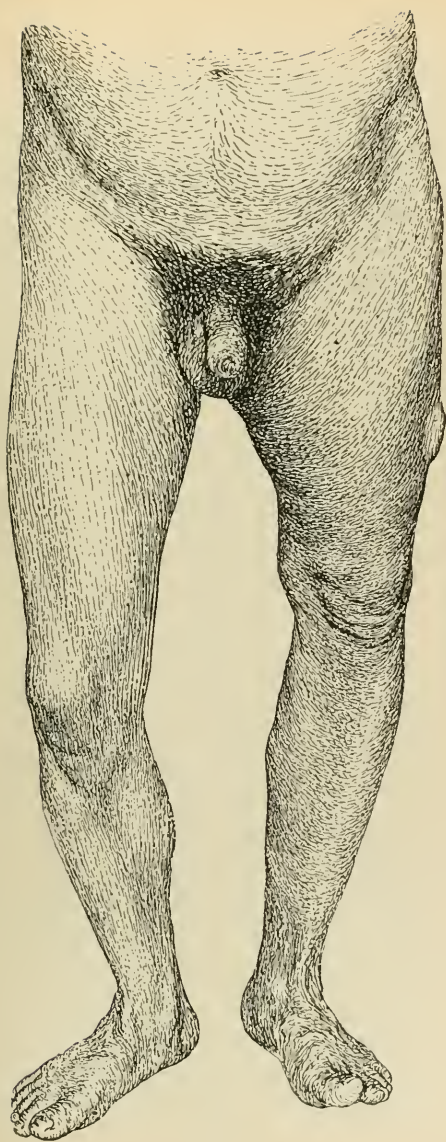


Fig. 64.

Case of fracture of the left femur, followed by shortening, backward displacement, and genu recurvatum.

A carpenter, forty-two years of age, is the subject of the accompanying illustration. (Fig. 64, p. 381.) On February 11, 1891, he fell with a scaffolding, sustaining the injuries mentioned. The illustration shows the overextension of the knee-joint, and also a muscle-hernia at the point of laceration of the fascia. The dark shading of the left leg represents the venous congestion that was present. Insurance allowance, $66\frac{2}{3}\%$ at first; subsequently, 50%.

Case of compound fracture of the right thigh. Sequels: marked degree of shortening; genu varum; ankylosis of hip-joint and knee-joint; slight ankylosis of ankle. (Fig. 65, p. 383.)

A carpenter, thirty-three years of age, fell from a scaffolding on June 24, 1895. He was treated in the hospital for seven weeks; an extension apparatus was used for five weeks. He received a course of after-treatment from September 19, 1895, until June 15, 1896. When discharged, he could bend the knee—which at the beginning of treatment had been completely ankylosed—to an angle of 130 degrees, and the hip-joint to an angle of 70 degrees. Insurance allowance, 60%. This comparatively high rate was based partly on complicating injuries (of head, etc.). No further improvement up to date.

Fractures of the lower third of the femur have a very decided effect on the position of the knee-joint, which is displaced in proportion to the proximity of the fracture to that joint.

The **symptoms** observed in connection with the knee-joint subsequent to fractures of the lower third of the femur are commonly as follows:

1. Flexion of the knee-joint (forward displacement, the variety most frequently seen). This is a typical form of displacement; the lower fragment is drawn downward by the gastrocnemius.

2. Overextension of the knee-joint, genu recurvatum (backward displacement, the least frequent form).

3. X-position, genu valgum (inward displacement, comparatively often seen).

4. O-position, genu varum (outward displacement, comparatively often seen).

Genu valgum is usually associated with flexion.

In addition to the special form of displacement of the knee-joint, the following symptoms are always present: shortening of the femur, depression of the pelvis on the



Fig. 65.

affected side, displacement in the hip-joint and ankle-joint, and atrophy.

The abnormal position of the knee-joint limits the movement of the joint, even to the point of complete immobility, and without the joint itself being involved in the fracture. The ankylosis may depend upon inflammatory adhesions that are particularly likely to form after comminuted fractures, or on too prolonged an employment of splints. In the latter case the stiffness can usually be overcome if mechanical treatment is begun in time. If delayed until after the thirteenth week, recovery is doubtful; at the best, a long course of treatment is required. Healing, in cases of compound fracture of the femur, necessarily involves the growth of scar tissue. (See Scars of the Thigh.)

Laceration of the fascia leads to the development of a muscle-hernia, which is, however, of no practical functional importance.

Fractures of the shaft of the femur are usually marked by a heavy growth of callus and by shortening and displacement. As already stated, the effect of the injury on the nearest joint is measured by the proximity of the line of fracture, the other joints of the extremity being secondarily and proportionately affected. After consolidation has taken place the part remains edematous and cyanotic, the cyanosis descending further and further on the leg; coldness and hyperidrosis of the toes are also to be observed. The muscles of the whole extremity are atrophied, and the skin is relaxed and feels withered; with advanced atrophy it can be lifted up in folds. The knee remains enlarged and swollen for a long time, as does also the ankle. Lameness is a constant symptom at first; patients use a crutch or a cane, and are often very clumsy in their movements for a time.

These disadvantages are best overcome by systematic mechanical treatment, consisting of massage, baths, exercises, electricity, and, at night, Priessnitz' compresses.

If a plaster cast is worn, it should, if possible, be made removable, in order to permit of early massage. Otherwise, it is well to apply the static breeze to the whole limb through the plaster cast, or possibly through the boots.

Spontaneous fractures of the femur depending on morbid conditions of the bone (locomotor ataxia, syphilis, tuberculosis, sarcoma) may occur in consequence of the most trivial accidents. Such fractures have been caused merely by drawing on a boot, by standing up quickly, by falling on the floor, etc. Healing takes place slowly, and there is always danger of recurrence. The patient is therefore greatly incapacitated for work, and the insurance allowance after recovery must be high—higher than after fractures of normal bone.

Pseudo-arthritis of the femur is due to the same causes that produce it elsewhere. Unless caused by the interposition of soft parts, the patient should be supplied with an appropriate support, and should be encouraged to walk as soon as possible, as by this method recovery can most quickly be brought about.

The **symptoms** are: shortening; in the beginning, edema of the whole limb, including the foot; edema in the uninjured extremity also; abnormal mobility at the point of fracture; and atrophy, which is especially marked below the fracture.

An insurance allowance of from 70% to 80% is justified, unless the patient is able to walk, fairly well by the aid of a support, in which case a somewhat lower rate may be granted.

Case of supracondyloid fracture of the left femur. Sequels, severe functional disability, ankylosis of the knee-joint.

The accompanying illustrations (Figs. 66 and 67, p. 387) show the enlargement of the left knee-joint, the position of flexion, and the shortening and atrophy of the limb. The knee is completely ankylosed. Insurance allowance, 50%. The skiagraph (Fig. 68) very beautifully shows the manner in which the fracture healed. The upper part of the shaft of the femur forms almost a right angle with the con-

dyles. Posteriorly, the condyles are connected with the shaft by a bridge of callus; the patella is firmly fixed between the condyles and the tibia. The patient in this case was a mason, forty-seven years of age, who had sustained the fracture in question by falling down a stone stairway ten or twelve steps.

Case of supracondyloid fracture of the femur, followed by partial recovery. (Fig. 69, p. 389.)

The subject of this illustration was a workman, fifty years of age, who fell from a ladder, dropping a distance of six feet, on August 24, 1896. The skiagraph greatly resembles the preceding one, but, when closely examined, shows certain points of difference. At first the knee-joint was much enlarged and was swollen and stiff. The course of after-treatment that the patient received in my clinic lasted from November 26, 1896, until May 22, 1897. When discharged, there was considerable improvement; he could fully extend the knee and could flex it to an angle of 70 degrees. He was conceded an allowance of 30%.

At present the patient does not limp; he can kneel down without any trouble, and walks well.

Case of severe comminuted supracondyloid fracture of the left femur.

The accompanying illustration (Fig. 70, p. 390) shows a patient, forty-four years of age, who sustained the foregoing injury by slipping with the left foot and falling to the ground. He was treated at home by the application of plaster casts, the first of which remained in position for two weeks, the second for three weeks; massage and innervations were then employed. I examined him and took a skiagraph on March 24, 1899.

The illustration shows marked thickening of the thigh and an extreme degree of shortening.

The skiagraph showed the shaft of the femur to lie between the condyles, from each of which a splinter of bone, about twelve centimeters long, protruded upward. The knee could be flexed to an angle of 90 degrees. The patient is still under treatment. It has not been possible to learn of any previous serious disease in this case, the patient maintaining that he has always been perfectly healthy, except that for one year he was "nervous." He served three years in the artillery.

Paralysis of the Thigh.

Paralysis of the crural nerve may be caused by traumatism of a severe nature, such as crushing of the thigh, or by a simple accident, like slipping and falling to the ground. Other causes are tumors, originating in the spinal column, tumors of the pelvis, or a psoas abscess. Oppenheim has reported a case due to an aneurysm of the femoral artery.

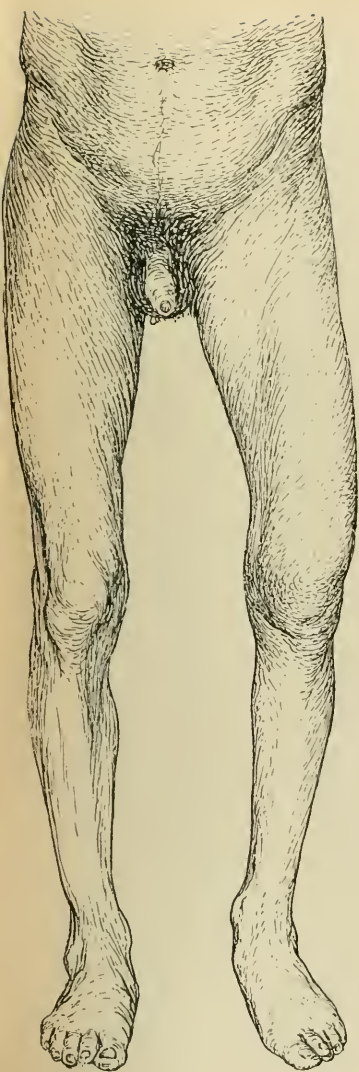


Fig. 66.

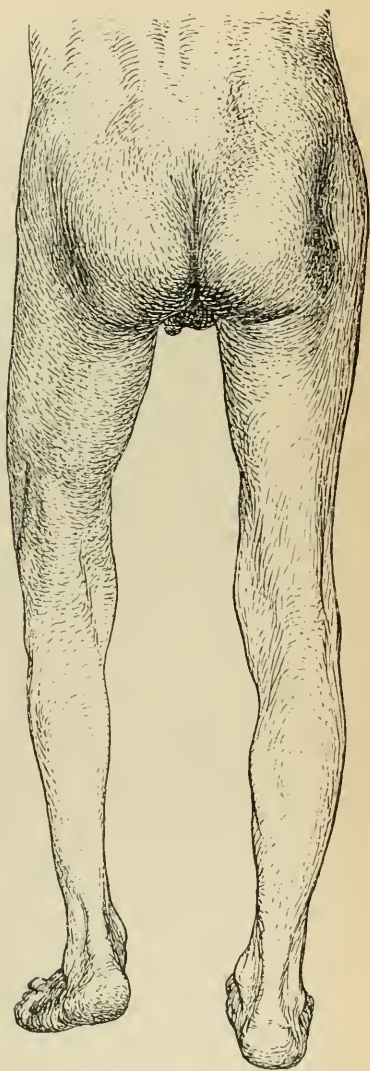


Fig. 67.



Fig. 68.



Fig. 69.

Symptoms.—Paralysis of the iliopsoas or quadriceps extensor and of the sartorius and pectineus. Flexion of the hip-joint is suspended; the patient is unable to rise from



Fig. 70.

a chair unassisted, or to raise the leg when lying on the back with the knee extended. The foot drags in walking, and in crossing a threshold it has to be swung around while the toes are lifted. In walking the weight is thrown on the opposite knee, while the affected one is held away from the median line. The patellar reflex is lost and the muscles are atrophied; there is anesthesia or hyperesthesia of the parts supplied by the middle and internal cutaneous and the long saphenous nerves: namely, the anterior and inner surfaces of the thigh, the inner side of the leg, and the inner border of the foot almost to the great toe.

Paralysis of the trunk of the sciatic nerve of traumatic origin is met with only in rare cases.

Symptoms.—Flexion of the knee is suspended; the leg drags in walking, and the tip of the foot can not be lifted.

Fracture of the Condyles of the Femur.

This lesion is usually part of a fracture of the joint, but even when the joint is not involved, the injury is commonly followed by ankylosis. It is most frequently caused by a fall—by striking the knee on a stone step, for instance.

Symptoms.—The knee is enlarged, or, more properly, broadened; the joint contains an effusion for a time after consolidation takes place; subsequently, it becomes ankylosed and fixed in flexion. The limb is shortened, the muscles are atrophied, and the patient walks with a limp. *Genu valgum* or *varum* is observed in some cases.

Treatment.—Recovery can be attained by means of massage and systematic passive movements when begun early.

Insurance allowance: if the knee is ankylosed in a position of extension, from 60% to 80%; if slightly flexed (about 160 degrees), 50%; if much flexed, from 70% to 80%.

Case of paralysis of the right thigh (crural nerve, quadriceps muscle) caused by a slip and a misstep.

A marble-polisher, sixty-five years of age, in lifting a heavy sack filled with soot, slipped, and in so doing stepped on a small, sharp stone, thereby forcibly extending the right hip. He felt a violent pain in the thigh, and was unable to lift the leg. He was treated at home for neuritis, or, rather, for concussion of the spinal cord and intrameningeal hemorrhage.

I examined him on December 14, 1896. The right knee was flexed at an angle of 165 degrees and was ankylosed in that position. The right gluteofemoral crease and the muscles of the right thigh were atrophied, especially the quadriceps. There was slight edema of the right leg and foot. The right patellar reflex was lost and there was a considerable degree of anesthesia; pin-pricks were not perceived. The patient was unable to lift the leg when it was extended, and in crossing a threshold was obliged to swing the leg over. There was marked anesthesia of the sole of the foot. The patient walked with difficulty and by using a cane. The following cutaneous nerves were involved in the paralysis: anterior crural, peroneal, anterior tibial, musculo-cutaneous, and communicans peronei.

The patient was discharged on August 26, 1897, with an insurance allowance of 66 $\frac{2}{3}$ %, afterward raised by the court to 85%, at which rate it has continued.

4. INJURIES AND TRAUMATIC DISEASES OF THE KNEE.

(263 Cases.)

Considerations on Anatomy and Function.—The knee-joint is capable of the following movements :

1. Flexion.
2. Extension.
3. Inward rotation when the knee is flexed.
4. Outward rotation when the knee is flexed.
5. Rotation of the tibia at the beginning and end of flexion and extension.

Flexion is produced by the semitendinosus, the semimembranosus, and the biceps (supplied by the sciatic nerve). During flexion the patella glides downward.

Extension is produced by the quadriceps extensor (supplied by the anterior crural nerve). During extension the patella glides upward.

The beginning and end of flexion and extension are both accompanied by rotation. In addition to its action as a flexor, the biceps serves to rotate the leg outward, while inward rotation is executed by the semitendinosus and semimembranosus. Flexion can be carried to an angle of about 40 degrees or something over. This angle is essential in order to kneel for any length of time with ease, while occasionally changing position by resting the buttocks on the heels. An angle of 60 degrees to 70 degrees suffices for kneeling ordinarily. A comfortable sitting posture calls for an angle of 120 degrees at the knee.

The articular surface of the patella terminates a finger's width above the apex of the bone; the roughened portion below is filled in by fat and by the subpatellar bursa; this bursa never communicates with the knee-joint. The capsule of the joint is attached to the periphery of the articular surface, which is covered by a cartilage, and also to the anterior margin of the femur. Under the tendon of the quadriceps extensor, in front of the lower end of the femur, lies the subcrural bursa, which invariably communicates with the joint, and which sometimes extends a handbreadth or more upward on the femur. It is occasionally divided into compartments, some of which may be entirely separated from the others. The extensor tendon is closely attached to this bursa.

The capsule of the joint is reinforced anteriorly and laterally by the aponeurosis of the knee-joint, derived from the quadriceps extensor, while internally it is additionally strengthened by the internal lateral ligament, to which it is firmly adherent. The internal lateral ligament expands as it passes downward, and is firmly attached to the internal semilunar fibrocartilage, into which its posterior fibers are inserted. The anterior portion of the ligament is continued downward as a separate band, to be inserted into the tibia. The external lateral ligament is separated from the capsule, or, rather, from the external semilunar fibrocartilage, by the tendon of origin of the popliteal muscle, which arises from the popliteal depression on the external condyle of the femur. The posterior portion of the ligament is

inserted into the head of the fibula. The lateral ligaments are put on the stretch during extension of the joint; they serve to fix the joint, and they prevent the movements of rotation, which can be executed when the joint is flexed. The capsule of the joint is reinforced posteriorly by fibers derived from the tendon of the semimembranosus, which have received the name of the oblique popliteal ligament. The bursa that lies under the tendon of the semimembranosus at the point of its insertion in the tibia is never in communication with the joint. The two heads of the gastrocnemius are attached to the capsule, and the bursae that frequently underlie them are always found to communicate with the joint. The plantaris, too, is adherent to the capsule. There are some thin points in the capsule posteriorly at which it is possible for ganglia to develop.

The popliteal artery and vein pass down close to the posterior wall of the capsule, separated from it only by the fibrous tissue surrounding the vessels, while the popliteal nerve is placed more superficially.

In the knee-joint are found the two crucial ligaments, which arise in the same lateral plane and are inserted respectively in front of and behind the spinous process of the tibia in the same anteroposterior plane. Thus they cross each other both from before backward and from side to side, and are wound about each other in a spiral fashion. The anterior crucial ligament helps in preventing overflexion; the posterior is put on the stretch by extension, thereby limiting this movement.

The head of the tibia supports the two semilunar fibrocartilages, which are attached by their convex borders to the capsule of the joint, while their sharp concave borders look toward the spinous process of the tibia, to which they are anteriorly and posteriorly attached. The two fibrocartilages are connected in front by the so-called transverse ligaments of the knee. The internal fibrocartilage is lower and less curved than the external.

On each side of the patella there is a fold of synovial membrane, inclosing adipose tissue, called the ligamentum alaria; the two unite near the femur to form the ligamentum mucosum. A synovial pouch is thus formed, directed upward and backward, in which foreign bodies may sometimes be lodged, without producing any irritation. The ligamentum mucosum frequently divides the lower part of the knee-joint into two lateral spaces, which merge above into one; or we can distinguish two spaces in the joint, one lying above the other. The lower space, which is somewhat the longer, corresponds in shape to the semilunar fibrocartilages, the upper is more pouch-like.

The synovial membrane lining the knee-joint is richly supplied with synovial fringes, some of which are of very large size (physiologic crepitation).

A bursa communicating with the joint is invariably found under the tendon of the popliteus muscle at its point of origin. The muscle is always closely attached to the joint-capsule, and the bursa is extended under the muscle down to the superior tibiofibular articulation, with which, in rare instances, it may communicate. In such a case the knee-joint and superior tibiofibular joint are connected; normally,

however, they are entirely separate. The prepatellar bursa, which, as its name indicates, lies in front of the patella, never communicates with the joint; occasionally, more than one bursa is developed in this situation.

The tibia and head of the fibula are closely and firmly united by the superior tibiofibular articulation, the capsule of which is strengthened by anterior and posterior ligaments. Normally, this articulation is completely isolated.

Contusions of the Knee-joint.

(175 Cases.)

The effects of contusions caused by falls, blows, or kicks, or when the knee is caught and compressed between two objects, may be displayed in an inflammation of one of the numerous bursæ around the knee or of the knee-joint itself. It is with the latter class of lesions that we are, for the moment, here concerned.

The **symptoms**, after the acute stage has passed, are : swelling ; presence of an effusion ; moderate heat in the joint ; possibly fixation of the knee in flexion ; atrophy of the muscles connected with the knee, particularly of the quadriceps, but also involving the flexors and, to a certain extent, the muscles of the leg. These symptoms persist for a long time. If the effusion is absorbed, the capsule of the joint will be found thickened on palpation.

Many cases show no signs of heat or swelling in the morning, while in the evening the joint appears very hot and swollen and contains an effusion. Such cases are not to be looked upon as cured, but should remain under treatment. If a patient complains of his knee being swollen at night, another examination should by all means be made at that time.

Later symptoms : restricted mobility of the knee-joint, cracking sounds on movement after the effusion is entirely absorbed, feeling of fatigue, and pain.

Treatment.—Rest ; immobilization by means of splints, the knee being extended as far as possible, and

suspended if feasible; in addition, cooling compresses, cold douches, Priessnitz' compresses, or compresses wet with a solution of acetate of aluminium, and acupuncture are to be recommended.

Subsequently, massage of the muscles of the thigh and leg, as well as of the knee itself, and electricity, should be employed. In walking, it is often necessary for the patient to wear an elastic knee-cap.

The insurance allowance while the knee remains weak and the muscles continue atrophied is usually estimated at 20%.

Sprains of the Knee-joint.

(Fifty-five Cases of Pure Sprains.)

Sprains of this joint may be caused by falling on the knee or on the feet, and by kicks on the knee, the popliteal space, or the leg near the knee; they also occur as a result of caving-in accidents, of springing from a carriage or from a flight of steps, or of simply turning the knee (usually inward), and similar accidents.

The sprain is accompanied by strain or partial rupture of the ligaments of the joint, as well as of the capsule, bursæ, and tendons. We sometimes, for example, find a partial or complete rupture of the internal lateral ligament together with a partial tear of the semilunar fibrocartilage at the point at which the ligament is inserted into it.

The **symptoms** are swelling, synovial effusion, and fixed position of the joint, as in cases of contusion. In addition, the internal condyle of the femur is often found to project distinctly when the knee is flexed, just as if it had been fractured and displaced and had healed in that position. If a skiagraph is taken, we can see that the spinous process of the tibia does not lie in the intercondyloid notch of the femur; the prominence of the internal condyle is also shown. This condition of subluxation is characteristic of a large proportion of sprains of the knee-joint. The more seriously the internal lateral ligament is

torn, the further can the bones be separated on the inner side of the joint (loose-jointedness). This causes a weakness of the knee and considerable difficulty in walking. Patients learn to hold the knee fixed as much as possible, in order to avoid turning it when they walk.

The longer the inflammation and effusion persist, the louder, as a rule, is the subsequent crepitation in the joint. The rubbing sounds are due to the proliferation of the synovial fringes, which in the knee-joint are normally present in large number, and which increase in size, as well as in number, when the effusion subsides. They seldom, however, have any influence on the action of the joint. The muscles of the thigh, especially the quadriceps, remain atrophied in proportion to the duration of the effusion. The atrophy of the vastus internus is often the most striking. I have found the atrophy of the quadriceps to last for two years, or even longer, after a sprain. Patients do not, as a rule, complain of much pain in the later stages of the inflammation.

Treatment.—The same as that for contusions. In addition, if loose-jointedness be developed in consequence of rupture of one of the lateral ligaments, a jointed support should be worn for walking. The course of treatment required, which for some cases of contusion covers a considerable period, is apt to be even more protracted when it is a question of recovery from a sprain. Even slight exertion is likely to bring on a relapse, with renewed swelling and effusion, demanding additional treatment.

Insurance allowance, from 20 % to 33 $\frac{1}{3}$ %.

Partial Rupture of the Ligamentum Patellæ.

This lesion occurs in connection with sprains, when, for example, the knee is turned or gives way suddenly when it is overextended. The injury to the ligament leaves the whole extensor apparatus (quadriceps including ligamentum patellæ) relaxed and the knee weak, while the muscles may remain atrophied for years. Primarily, the

quadriceps is affected; secondarily, the atrophy also involves the other muscles of the thigh.

A carpenter, twenty-five years of age, slipped on a smooth plank; his knee gave way and he fell on his back. He felt a pain in the knee and was unable to rise. An effusion took place into the joint. A skiagraph taken somewhat later showed the partial rupture of the ligamentum patellæ and the displacement of the patella upward. In addition, the muscles of the thigh were greatly atrophied (circumference diminished by four centimeters), and the knee was exceedingly weak. The patient was able to extend his knee to 145 degrees, and to flex it to 55 degrees. The patellar reflex was lost. Insurance allowance, 50%.

Complete Rupture of the Ligamentum Patellæ.

This lesion is seen even less frequently than the preceding. It occurs under the same conditions as do the fractures of the patella that are produced by muscular action.

The **symptoms** subsequent to the acute stage are: effusion; swelling; and, unless the ruptured tendon is sutured, loose-jointedness; and an extreme degree of atrophy of the quadriceps. The knee feels weak and insecure, as does the whole limb, and the patient is unable to extend the knee or to fix the patella.

Treatment.—The tendon should be sutured (Helfferich's method) in all cases. In other respects the treatment is the same as for sprain.

Injuries of the Bursæ of the Knee.

The bursæ are sometimes injured in cases of contusion or sprain of the knee-joint. When a communication exists between the affected bursæ and the knee-joint, we find a diffuse effusion, making the outlines of the patella indistinct. The **symptoms** in such cases are identical with those of a synovitis of the knee. When no such communication exists, it is possible for the exudate in the acute stage of the bursitis to break through into the joint. The pain usually disappears before the subacute or chronic stage is reached, unless melon-seed bodies should develop, as frequently happens when the prepatellar bursa is in-

volved. In other respects this bursa gives less trouble than any of the others. When one of the isolated bursæ is attacked by inflammation, the symptoms vary somewhat, according to the location. In case, for instance, of a pre-patellar hygroma the quadriceps, after absorption of the effusion, may show no appreciable evidences of atrophy, while it is, as a rule, noticeably affected by a hygroma under the tendon below the patella.

Treatment.—When the effusion is absorbed, massage and electricity should be employed, and a knee-cap should be ordered. Exertion is likely to produce a relapse.

Insurance allowance, from 20 % to 25 %.

In one case under my observation the patient, a carpenter, forty-eight years of age, suffered from a bursitis under the heads of the gastrocnemius, brought on by twisting the knee, in January, 1898. A tense elastic tumor could be felt under the heads of the muscle; the knee-joint was swollen and contained an effusion; it was also weak, and its mobility was restricted. The muscles were atrophied and the leg was edematous. The patient was under treatment from August 27, 1898, before which date he had not obtained medical advice, until July 28, 1899. Insurance allowance at first, 33½ %.

Wounds and Scars of the Knee.

Wounds of the knee are met with in carpenters and wood-choppers, as the result of a blow from an ax or hatchet; punctured wounds caused by a sharp instrument, such as a chisel, are likewise seen. As such wounds are likely to extend deeply into the tissues, and to involve the bone, subsequently forming cicatricial adhesions with the latter, their effect on the functional action of the joint becomes very serious.

The process of healing and the subsequent effect of the scar depend largely on the question of infection of the wound. Punctured wounds which directly pierce the capsule of the joint may be very quickly followed by a suppurative synovitis. Even simple contused wounds may lead to a cellulitis, and subsequently to ankylosis, the latter depending on the operation-scars, as well as on intra-articular adhesions. Extensive scars situated over

the knee or close to it limit its action to a very considerable degree. As a rule, the patient finds it easiest to keep the knee slightly flexed, on whatever part of the knee the scar is situated. Unless the knee is moved with some caution, the scars are very likely to break open. This is especially the case when the scar lies upon, and is adherent to, the patella, in which situation it is likely to be injured by unguarded or frequently repeated movements of flexion, while scars of the popliteal region may be torn open by movements of extension. Similar effects are seen when the scars are situated at the side of the joint. In addition to this constant danger of injury to the scar, recovery is further interfered with by more or less atrophy of the muscles.

Treatment.—Gradually to stretch the scar-tissue, and so to restore the mobility of the joint, is the aim of treatment, and is accomplished by means of warm baths, warm packs, massage, exercises, and galvanism. In some cases only a certain degree of improvement can be reached; the scars, however, often become gradually loosened spontaneously, although the process may cover a number of years.

The working capacity of the patient, when the mobility of the joint is much affected, may be very considerably reduced.

Insurance allowance in light cases 25%; in severe cases from 50% to 60%.

Punctured wound of the left knee followed by suppurative inflammation and ankylosis.

A carpenter's apprentice, seventeen years of age, injured his left knee with a chisel. It became swollen and inflamed, and suppuration set in. He was treated in the hospital from September 8, 1894, until January 16, 1895, the knee having been opened in several places. He then attended my clinic until September 24, 1895. At first the knee was entirely stiff, and was set at an angle of 150 degrees; when the patient was discharged, it was held at an angle of 170 degrees, and could be flexed to 125 degrees, thus allowing of a flexion of 45 degrees. The knee was marked with deep scars, in part attached to the bone; the muscles of the thigh were greatly atrophied, the circumference being diminished five or six centimeters. Insurance allowance,

45%. At the time of an examination made on April 16, 1898, no noteworthy improvement was apparent; the patient was unable to kneel.

Another case of injury of the knee-joint, caused by a blow from an ax, and followed by suppuration, concerned a carpenter, fifty-four years of age, who was treated at home from the day of his accident, August 30, 1890, until September 22, 1890, when he entered the hospital for operation, remaining there until January 24, 1891. He attended my clinic from April 10, 1891, until October 23, 1891. The scars on the knee were adherent to the bone, and flexion was limited to 115 degrees, the knee being held at an angle of 180 degrees. The muscles were atrophied and the patient was unable to kneel. Insurance allowance, 40%.

Case of retracted cicatrices over the patella and on the outer surface of the knee-joint, caused by a contusion and suppurative inflammation. Sequel, tubercular arthritis of the knee; death from pulmonary tuberculosis.

A workman, twenty-seven years of age, was struck on the left knee by a stone, on November 23, 1891. The injury was followed by swelling, inflammation, and suppuration. The patient entered the hospital for treatment; skin grafting was attempted, but was unsuccessful. The wounds required treatment until December 30, 1892. Afterward there was left a deep scar extending along the whole outer side of the thigh, down to the knee. The scar over the patella showed signs of inflammation, and could be broken open when the knee was flexed to an angle of 85 degrees. The leg was edematous and the muscles of the thigh were greatly atrophied. Movements of the knee-joint caused crepitation. Subsequently, the patient was able to work and to mount ladders, and received full pay. The first signs of local tuberculosis appeared at the end of 1896, and the patient succumbed to pulmonary tuberculosis at the end of 1897.

Dislocations of the Knee-joint.

(Sixteen Cases of Reduced Dislocation Form the Basis of This Section.)

Dislocations of the knee-joint are seldom seen, an extreme degree of violence being required for their production.

The joint remains swollen for a long time after reduction, and, in addition, we find the following symptoms: subluxation of the joint; loose-jointedness or more or less complete ankylosis; genu valgum or varum; crepitation on movement; atrophy of the whole limb, especially of the quadriceps; restricted mobility; and difficulty in walking.

Treatment.—Stiffness is to be overcome by gymnastic exercises, by massage, and by passive movement. In case of loose-jointedness the patient should be supplied with a supporting apparatus.

The working capacity is diminished in proportion to the degree of stiffness, of flexion, and of functional disability; the insurance allowance varies from $33\frac{1}{3}\%$ to $66\frac{2}{3}\%$.

Forward or backward dislocations sometimes cause injuries of the blood-vessels, which may be followed by gangrene. In the latter case amputation is indicated.

In a case of dislocation of the left knee-joint caused by falling from a wagon, in which the patient was a painter, twenty-eight years of age, the symptoms one year after the injury (reduced in the hospital) were as follows: subluxation of the knee-joint (the bones of the leg were displaced backward and outward); restricted mobility, flexion being limited to 90 degrees; a slight degree of genu varum; loose-jointedness; muscular atrophy. Insurance allowance, $33\frac{1}{3}\%$. A knee-support was recommended.

Subluxation of the Knee-joint.

This lesion is frequently met with, as a direct result of injury or as a consequence of an angular deformity after fractures in the vicinity of the joint or of a reduced dislocation. It is often observed as a sequel to a sprain. As a rule, we find the internal condyle of the femur displaced inward or the tibia somewhat displaced backward. Other forms of displacement are also met with.

Internally, the knee-joint usually appears thickened, while the knee is slightly flexed and is directed inward (valgus); less frequently it is directed outward (varus). The muscles of the thigh and leg are atrophied, and the knee-joint is restricted in its movements, which are apt to remain painful for a long time. In severe cases the gait is much affected and the patient is unable to kneel.

The **treatment** is symptomatic. In favorable cases functional power may be regained in from six to eight weeks, or even sooner, but in others a long course of treatment is required. If the symptoms just mentioned persist, especially the pain, an insurance allowance of from

$33\frac{1}{3}\%$ to 50% is made. In light cases from 15% to 20% is sufficient.

Case of subluxation of the left knee-joint, with very protracted recovery.

A workman, thirty-eight years of age, in unloading some building material, on May 16, 1898, fell backward from the wagon, catching his left foot in a chain. He was taken to a hospital, where for two weeks he was treated by splints, cold compresses, and massage. He attended my clinic from August 13, 1898, until February 17, 1899. The left knee-joint was fixed at an angle of 160 degrees; it was swollen and thickened on the inner side. The muscles of the thigh were greatly atrophied (circumference diminished four centimeters); extension was limited to 160 degrees and flexion to 90 degrees. Movement was very painful, and the patient walked with great difficulty, leaning on a cane. When discharged, movement was considerably improved; there was no pain and no difficulty in walking. Insurance allowance, 25% .

Case of subluxation of the knee-joint with rupture of the internal lateral ligament.

The patient, who was a workman, turned and dislocated his knee in stepping on a stone. When I examined him, on November 17, 1891, the bones of the joint could easily be drawn apart on the inner side and the muscles of the thigh were greatly atrophied. The patient wore a support. Insurance allowance, 45% ; later on, 25% .

Another case concerned a mason's apprentice, eighteen years of age, who had dislocated the right knee by falling from a scaffolding. The knee subsequently became directed inward and was overextended. Loose-jointedness was a marked symptom, and was due to the rupture of the internal lateral ligament. A knee-support and massage were prescribed. The course of treatment in my clinic extended from February 16, 1891, until May 21, 1891. Insurance allowance, $33\frac{1}{3}\%$, reduced in May, 1896, to 20% , as the patient was then able to work at full pay. Otherwise his condition remained unchanged.

Dislocation and Rupture of the Semilunar Fibrocartilages.

These accidents are uncommon; they are caused by violent rotation of the end of the femur when the knee is flexed.

Remote Symptoms.—Flexed position of the knee-joint; effusion in the joint; sometimes a slight local rise of temperature; snapping movements, accompanied by pain; inability to extend the knee; and muscular atrophy. The appearances may so closely resemble those produced by the presence of loose cartilages in the joint as to make a differential diagnosis almost impossible.

Treatment.—This consists in the use of a knee-cap or a supporting apparatus, in massage, etc. Insurance allowance, from 25 % to 50 %.

Case of strain of the left knee-joint. Sequels, aneurysm of the popliteal artery, and gangrene. Amputation of the leg.

A mason, forty-nine years of age, slipped with his left foot in lifting a carpenter's horse, and immediately felt a violent pain in the knee. At first he continued work, but entered the hospital three weeks later, where he remained for three weeks. An operation (doubtless incision) was performed; gangrene set in and amputation became necessary. Insurance allowance, 75 %.

Dislocation of the Patella.

This lesion is most frequently seen in the form of an outward dislocation, a fact which is easily understood if we consider the anatomy of the knee.

Unless reduced, the signs of displacement remain very evident; genu valgum is also found, as a rule, and the muscles of the limb, especially of the thigh (quadriceps), are atrophied. The mobility of the knee is usually restricted, but in some cases is restored in the course of time.

For some time subsequent to reduction the knee remains swollen, flexed, and in a position of valgus, while the muscles regain their normal condition only very slowly. Recurrence of the dislocation is quite frequently observed.

Partial dislocations of the patella are often met with.

The **treatment** is symptomatic.

Insurance allowance, from 25 % to 33 $\frac{1}{3}$ %, or more in severe cases.

Fractures of the Patella.

(Thirty-two Cases.)

Indirect fractures resulting from muscular action are the usual form of the lesion; direct fractures, however, are also met with. The accident is usually caused by suddenly slipping and forcibly flexing the knee, while at the same time the body is thrown backward; the quadriceps is reflexly contracted, snapping the patella in two. The

line of fracture is transverse. Less commonly, the effect of the contraction of the muscle is manifested in a rupture of the extensor tendon above or below the patella. The direct form of fracture is produced by a fall on the knee, striking against the edge of a threshold, for instance, or by a blow on the knee. These fractures are very frequently comminuted. The best results as to functional power are obtained by wiring the fragments.

Symptoms :

(a) *When the fragments are united by suture and the wound has completely healed.*

There is a scar on the anterior surface of the knee, which at first is swollen ; atrophy of the muscles of the thigh, especially of the quadriceps ; secondary atrophy of the muscles of the leg and foot ; restricted mobility of the knee.

In cases of simple transverse fracture the quadriceps may be only slightly atrophied, and soon recovers ; after comminuted fractures I have found the atrophy to be much more marked, which may have been partly due to the fact that splints had been applied for a long time.

Treatment.—Systematic exercises, etc., to restore mobility and to overcome atrophy.

Insurance allowance, in light cases 20 %, and in severe cases $33\frac{1}{3}$ % at first ; when improvement begins to appear, the rate can be proportionately diminished.

(b) *When fibrous union has taken place.*

The fragments are separated, in some cases so much so that the hand can be laid between them when the knee is flexed ; the muscles of the whole limb are atrophied, the atrophy being most pronounced in the case of the quadriceps ; loose-jointedness, inability fully to extend or flex the knee and disturbances of gait are also manifested. When he puts the foot to the ground in walking, the patient usually holds the knee stiff and away from the median line. Functional power is not lost unless the lateral ligaments are ruptured. A bad prognosis obtains

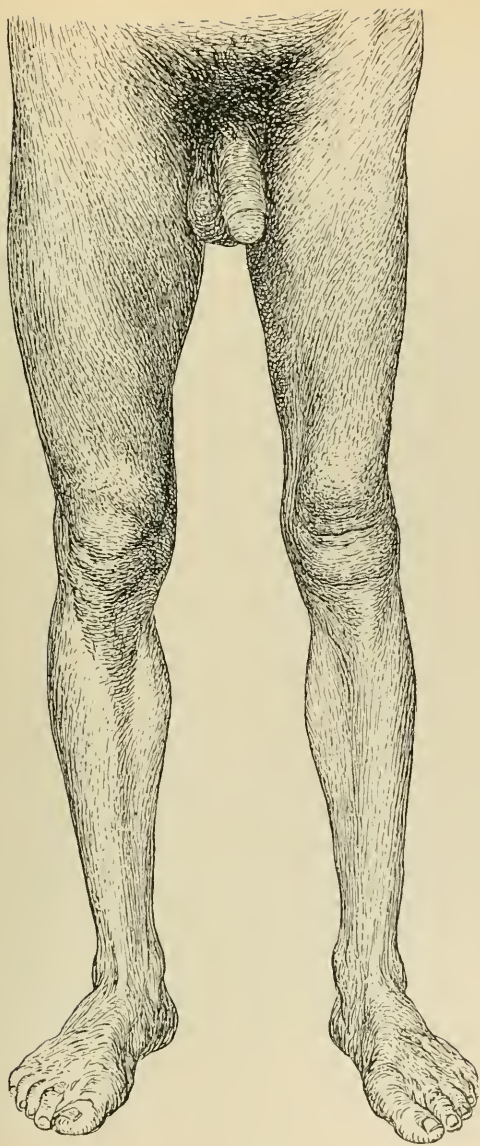


Fig. 71.

for cases complicated by rupture of the lateral ligaments, or for those in which the lower fragment becomes wedged in between the femur and tibia, and unites in this position. In the former instance the power of extension is lost, while in the latter the knee remains permanently stiffened.

Treatment.—If the fragments are widely separated, and if loose-jointedness is manifested, the patient is obliged to wear a jointed support at first; subsequently, this can be replaced by a simple knee-cap. For the muscular atrophy nothing can be done. The usual treatment of ankylosis—by exercise, massage, electricity, baths, etc.—is to be employed.

Insurance allowance, usually from $33\frac{1}{3}\%$ to 50% .

It is very questionable whether we are justified in regarding the atrophy of the quadriceps as always of reflex origin, connected with morbid processes in the spinal cord, since in most cases the condition can be fully explained on mechanical grounds alone. The fact that the points of attachment of the quadriceps, more particularly of the rectus, are approximated by the upward displacement of the upper fragment, is a sufficient cause for the atrophy. Secondly, it is true, the atrophy also involves the flexors, the muscles of the buttocks, leg, and foot, and in certain cases it may be proper to attribute it to disorder of the central nervous system. As a rule, however, no such explanation is necessary. The atrophy persists for many years. If the lateral ligaments remain intact, the muscles sometimes recover to a large extent even though the fragments are widely separated. In other cases the atrophy gradually increases.

Case of indirect transverse fracture of the left patella, followed by severe functional disability. (Fig. 71, p. 405.)

A workman, twenty-six years of age, when carrying a carpenter's horse, on January 28, 1893, slipped and fell over backward. He was treated in the hospital and subsequently in the dispensary. When I examined him on April 22, 1893, I found the fragments separated to the degree shown in the accompanying illustration. The patient was unable to lift the leg except with much exertion, and it dragged in walking. Extension and flexion of the knee-joint were almost sus-



Fig. 72.

pended, and the whole limb was atrophied. The circumference of the middle of the thigh was diminished 6 cm., that of the knee 5 cm., and that of the calf nearly 2 cm. The patient was obliged to wear a supporting apparatus. At the time of another examination, in November, 1896, I found the atrophy still more advanced; the circumference at the level of the iliofemoral crease was diminished 8 cm., that of the middle of the thigh 9 cm., and the knee 2 cm.

Insurance allowance, 60%. No improvement up to the present time.

Case of indirect fracture of the patella caused by muscular action, on the occasion of a fall from a scaffolding. (Fig. 72, p. 407.)

A workman, twenty-six years of age, sustained a fracture of the patella as just stated. Some improvement has gradually taken place in the course of time, since the lateral portions of the extensor aponeurosis remained intact. The interval between the fragments admitted the full width of the hand. The atrophy was extreme at first, the circumference of the thigh being diminished $6\frac{1}{2}$ cm. At the present time there is only a slight difference in the measurement of the two sides. The patient can walk very well and can do light work. Insurance allowance, 50%; later, $33\frac{1}{3}\%$.

Case of direct fracture of the right patella. (Fig. 73, p. 409.)

A mason, thirty-eight years of age, fell from a scaffolding on April 13, 1897, striking on the right knee and left hand. An extension apparatus was applied for seven weeks in the hospital. The patient was subsequently treated in my clinic from July 14, 1897, until June 22, 1898. He was a tall, stout man; the right knee was completely ankylosed and greatly swollen; it was fixed at an angle of 175 degrees, and the muscles were greatly atrophied. The accompanying skiagraph was taken four weeks after the first examination. The lower fragment was firmly fixed between the tibia and the femur. When discharged, the knee could be actively flexed only to an angle of 120 degrees; there has been no subsequent improvement. The patient has meanwhile developed a severe case of tuberculosis.

Case of direct comminuted fracture of the right patellar. (Fig. 74, p. 410.)

The knee was put up in plaster for fourteen and a half weeks, and the patient was then allowed to walk. He was treated in my clinic from January 13, 1898, until March 19, 1898. The knee-joint was swollen, and the outline of the patella was indistinct. On palpation the patella felt somewhat uneven. Flexion was limited to an angle of 125 degrees.

At the time of his discharge flexion was increased to an angle of 85 degrees, and there was no difficulty in walking. The shape and displacement of the patella are clearly shown in the skiagraph, in which the line of fracture can also be easily traced.



Fig. 73.



Fig. 74.

Fractures of the Knee-joint.

(Fourteen Cases Involving the Femur or Tibia.)

The lesion may consist of a fracture of the articular extremity of the femur, of the tibia, or of both. The knee is usually left weak, ankylosed, and fixed in extension or flexion. The muscles connected with the joint undergo atrophy.

The disadvantage of a stiff knee to a workman is usually greater when the knee is extended than when moderately flexed—say, at an angle of from 145 to 155 degrees. Lameness in the latter case can be obviated by wearing a raised shoe, and the patient may then be able to mount and ascend a ladder with a load on his shoulder. He is also better able to put on and take off his trousers, to board horse-cars, omnibusses, etc., than if the leg were fixed in extension.

The prognosis is more favorable as to functional power if only partial ankylosis exists, or if the fixation is due to a contracture which still permits of some movement of the joint. When the stiffness is due to resection, the insurance allowance is usually rated higher than otherwise, because of the additional shortness of the limb.

Insurance allowance, when the knee is fully extended, from 50 % to 60 % ; when flexed at an angle of about 160 degrees, from 25 % to 33½ % ; when greatly flexed, necessitating the wearing of a wooden leg, from 70 % to 80 %. The rate is considerably affected by the ability or inability of the patient to kneel.

Tuberculosis of the Knee-joint.

Traumatism, when it affects a tuberculous individual, not infrequently acts as the exciting cause of tubercular inflammation of the knee-joint. The injury may be slight or serious, such as a contusion, a sprain, a fracture, etc. It may be possible to prevent the local de-

velopment of the disease if the patient is placed under treatment immediately after the accident, but if the synovitis once gains headway, it leads to the development of an obstinate and destructive inflammatory process, which may progress indefinitely, doing irreparable damage to the joint. Resection is often indicated. Sometimes the pus works its way to the surface and the inflammatory process comes to an end, leaving the joint stiff and deformed and marred by scars.

Symptoms.—Insidious onset and development of the inflammation; swelling of the knee, marked by tension and absence of effusion; gradual change of shape of the part; fever, atrophy, etc.

Insurance allowance during the acute or subacute stage, 100%.

Chronic Traumatic Inflammation of the Knee-joint; Arthritis Deformans; Osteo-arthritis of the Knee.

When the knee-joint is severely contused or crushed it may become the seat of a chronic inflammation (arthritis deformans), especially if the affected individual is subject to frequent attacks of rheumatism. The functional power of the joint is considerably diminished, and the patient is frequently obliged to stop work on account of pain in the joint, especially when the weather is changeable. The knee-joint becomes greatly enlarged and deformed; it is completely or partly ankylosed, and, as a rule, is flexed and partly dislocated.

It may be many years before the patient is completely incapacitated for self-support.

Insurance allowance, according to the severity of the case, $33\frac{1}{3}\%$ or more.

Case of traumatic arthritis deformans involving the knee.

A woman forty-five years of age sustained in her twentieth year, a fracture of the left tibia just below the knee. She was under treatment for eight months, afterward resuming work in a factory. In consequence of repeated contusions received during subsequent years the left knee gradually became more and more swollen and misshapen.

When I examined her, on March 3, 1899, I found the knee greatly deformed; it was much enlarged, flexed, and in a position of varus; it was almost completely ankylosed and was very painful. The muscles were atrophied and the part was cold. The patient complained of severe pain. Insurance allowance, 50%.

5. INJURIES AND TRAUMATIC DISEASES OF THE LEG.

Injuries Due to Contusion.

(156 Cases, Including Wounds.)

Slight contusions of the tibia are usually followed by rapid and perfect recovery. Even in case of extensive blood extravasations, which, on account of the vascularity of the part, are frequent, the injury, if properly treated, does not lead to subsequent functional disability.

The periosteitis caused by contusions seldom gives rise to much, if to any, pain, and does not, as a rule, prevent the patient from working. If, on the other hand, the periosteitis appears in connection with a contused wound, which subsequently becomes infected, the consequences may be very serious.

A workman, thirty-five years of age, grazed his right shin in using a heavy hammer, causing a slight abrasion of the skin. A suppurative periosteitis developed; the wound continued to discharge for a year, when it finally healed, leaving a broad, shining scar, adherent to the bone and exceedingly sensitive. The slightest touch, even of the surrounding skin, would cause violent contractions, and very intense and long-continued tetanic spasms could be produced by testing the patellar reflex. The knee was weak and was fixed in flexion; the patient walked with difficulty, leaning on two canes. Insurance allowance, 100%.

Contusions of the Calf.

These usually run a favorable course, absorption of the hemorrhagic extravasation being quickly promoted by appropriate treatment—rest, compresses, etc. The same may be said of contusions affecting the tendo Achillis. The prognosis becomes more serious, however, when the leg is crushed under heavy objects, such as beams, stone slabs, iron rails, etc., or when the individual is caught in

a caving-in or is run over. Such accidents are likely to cause extensive wounds, simple or compound fractures, ruptures of muscles and tendons, and lacerations of the fasciæ. When fractures are present, the usefulness of the part is usually permanently impaired; otherwise, if properly treated, no permanent functional disability need follow. The course of treatment, however, is apt to be protracted.

Although in simple cases of crushing of the leg a favorable result may usually be expected, the outlook becomes very different when the leg is the seat of some morbid process. Quite apart from the disproportionate effects of slight injuries in the presence of a constitutional disease, such as locomotor ataxia,—when simple contusions, for instance, may cause a fracture,—when the leg is affected by varicose veins or cicatrized varicose ulcers it needs only the irritation consequent upon a contusion or slight abrasion to excite an inflammation leading to the development of new ulcers or to the reopening of old ones. The ulcers may become as large as the palm of the hand, and unless the process is brought to a termination, may be followed in the course of time by swelling and inflammation of the whole leg (*elephantiasis cruris traumatica*). When the inflammation is severe, the patient should remain in bed, with the leg elevated, and the wound should be kept scrupulously clean. A 2% to 4% solution of acetate of aluminium is sometimes remarkably efficacious. If there is no marked inflammatory reaction in the surrounding tissue, and it is only a question of cicatrization of the ulcers, it is advisable in many cases to use a prepared zinc bandage, which enables the patient to continue work and may not need renewal for a week or two. These zinc bandages are certainly of great service to working-men suffering from varicose ulcers. If such a man were to be sent to the hospital every time a healed ulcer should break down afresh, he and his family would be reduced to starvation. The bandages are highly valued by both doctors and patients;

many workmen treat themselves, indeed, on the same principle, although imperfectly, by using ointments and bandages, and perform the same tasks, year in, year out, as their healthy comrades, although the ulcers remain open and suppurating. We should, however, insist on seeing a patient at least once or twice a week, changing the bandage as soon as it is soiled through by secretion. The patient must be impressed with the necessity of going at once to the physician when this occurs. As the traumatism is usually responsible, at the most, for no more than a new outbreak of the old trouble, 20 % is ordinarily a sufficient insurance allowance when the patient is able to work, with due consideration for the likelihood of recurrences.

In respect to wounds of the leg, incised wounds are among the most important. They are seen in carpenters and others whose work exposes them to accidents with hatchets or axes, or in farm-hands who handle scythes. They heal, as a rule, without difficulty, and the scars give no trouble, unless by reason of deep attachments. The results are, of course, serious when tendons, vessels, or nerves are involved in the cut. Infected wounds of the leg, which in healing form cicatricial adhesions with the bone, are characterized by extreme sensitiveness, which in some cases rather increases than diminishes after the scar is fully formed.

The wounds of the back of the leg, with which we have to deal, are usually caused by a scythe, and involve either the calf or the tendo Achillis. Wounds of the calf usually heal without further difficulty. Healing, when the tendo Achillis is severed, is a slower process, but is likely to terminate favorably. Unless primary union takes place, a cicatricial contracture of the tendon is likely to be developed, causing flexion of the knee and talipes equinus. The action of the ankle-joint is restricted and cramps of the muscles of the calf are frequently observed. These unfavorable results can be entirely overcome, however, by massage, baths, and electricity.

Case of division of the tendo Achillis, followed by cicatricial contraction and relatively slight functional disability.

A workman, forty-five years of age, cut the back of his leg with a bread-knife, completely severing the tendo Achillis, on June 26, 1897. He was treated in the hospital, where the tendon was sutured; the wound, however, healed very slowly. It was still open when the patient came under my care, on October 23, 1897. After healing it left a firmly adherent scar, extending to the internal malleolus. The knee was slightly flexed, and there was a slight tendency toward talipes equinus. The muscles of the calf were atrophied and were subject to cramps. The mobility of the ankle and toes was somewhat restricted, and there was a feeling of numbness in the heel and the sole of the foot. The patient made considerable improvement. Insurance allowance, 20%.

Burns and Scalds of the Leg.

In severe cases healing is very protracted, and when it finally takes place patients find it very difficult to walk or to bear their weight on the affected leg for a long time. At first they are obliged to use crutches, and always complain of a feeling of great insecurity in the leg, which is only slowly and gradually overcome. The scars in some cases present zones of extreme hyperesthesia, while in other cases analgesia is manifested.

Subcutaneous ruptures of the muscles of the calf occur in the lower part of their course, usually as the result of reflex contraction of the muscles, following a fall or a leap, landing on the feet. Occasionally, only the posterior extremity of the os calcis is torn off; less frequently, the muscles give way where they merge into the tendo Achillis, and in rare cases the extremity of the os calcis is torn off and the tendo Achillis is ruptured at the same time. The subject will be referred to again under Fractures of the Os Calcis.

Case of scald of both legs and feet followed by very protracted recovery.

A painter, thirty-three years of age, fell from a scaffolding into a boiler full of boiling water on June 4, 1889, sustaining the foregoing injuries. He was treated in the hospital until September 20, 1889. I examined him at his home on September 23, 1889. He was utterly unable to walk, or even to stand. About three months later he began to walk with two crutches. Both ankles were encircled by smooth, superficial scars; both legs, more particularly the right, were like-

wise badly scarred. The muscles were slightly atrophied and the temperature of the skin was lowered. The scars were extremely sensitive and the legs appeared strikingly weak. The patient was discharged on April 21, 1891, with an insurance allowance of 33 $\frac{1}{3}$ %.

On October 14, 1896, he appeared for examination, complaining of feeling worse. There were fibrillary and clonic contractions of the muscles of both legs; the patellar reflexes were extremely exaggerated and ankle-clonus could be obtained on both sides. The patient walked very cautiously and slowly, and swayed when his eyes were closed. There was numbness of the soles of both feet. The muscles were not atrophied. Pulse, 100; irregular.

The insurance allowance was raised to 50%.

Fractures of the Leg.

(190 Cases.)

Fractures of the Upper End of the Tibia.—The typical fracture in this situation is due to compression of the bone in its long axis, as a result of such accidents as falling squarely on the feet from a height, jumping from a bicycle, etc.

When the injury is slight, the tibia is only fissured; in severe cases the upper end of the bone is driven more or less into the shaft, or the upper articular surface is flattened and broadened, or the effect of the violence may be still differently manifested—by a concave depression in the head of the tibia corresponding to the convexity of one of the condyles of the femur which was forced into it. The fibula is always involved in cases of severe compression.

As these fractures involve the joint, they may be further complicated by injuries of the semilunar fibrocartilages, which are sometimes thrown out of position, and perhaps also by a fracture of the spinous process of the tibia. Symptoms of inflammation of the knee-joint are always present at first.

Symptoms subsequent to consolidation: The leg is shortened; the knee is thickened and enlarged; the head of the tibia presents an increased circumference and a deformity which remains after the swelling subsides; the joint is in a position of subluxation, with varus or per-

PLATE 33.

Case of Compression-fracture of the Left Tibia and Head of the Fibula, Due to Falling from a Scaffolding, Landing on the Feet. (See Fig. 75, p. 419.)

A mason, thirty-eight years of age, sustained the foregoing injuries on June 11, 1896. He was treated in the hospital for eleven weeks, and subsequently in an "institute for mechanical treatment" for thirteen weeks. He began to attend my clinic on February 28, 1898. The accompanying illustration was made shortly before his discharge. The left leg is distinctly shortened, the knee-joint is thickened and slightly rotated outward, there is a slight degree of genu varum, the leg is somewhat swollen, and the thigh is atrophied. The skiagraph (Fig. 75, p. 419) shows the fracture very clearly.

haps valgus; the whole leg shows signs of atrophy; the knee-joint is partly or completely ankylosed; if movement is permitted, it is accompanied by crepitation. Further symptoms are lameness, pain, secondary displacements of the hip and ankle, and, frequently, an inability to kneel.

Treatment.—The knee is to be mobilized by exercises and massage; a boot with raised sole is sometimes to be recommended. A very long course of treatment is required in unfavorable cases, the symptoms previously named being very persistent. Insurance allowance, from 25 % to 50 %.

Fractures of the Leg Near the Knee.—The consequences of these fractures are manifested both by displacement and loss of functional power of the knee-joint. We find the leg shortened and the knee-joint thickened, as is also the head of the fibula, if this was involved in the fracture. There is genu valgum or varum, the muscles are atrophied, the mobility of the knee-joint is restricted, and there is difficulty in walking.

Corresponding secondary displacements are manifested in both the hip-joint and the ankle-joint.

Separation of the tubercle of the tibia caused by muscular action is never more than a partial separation, and is rarely met with in adults. The lesion is usually of a







Fig. 75.

PLATE 34.

Case of Genu Valgum Following a Fracture of the Leg Just Below the Knee. (See Fig. 76, p. 421.)

A workman, twenty-seven years of age, was injured as just stated on February 4, 1898, by a pail falling against the outer side of his left leg. The patient was treated at home in the country; splints were applied for one day, a plaster cast being substituted on the following day. Eight weeks after the accident he began to walk with the aid of a crutch and a cane. He was treated in my hospital from May 15, until August 18, 1898. The form of the fracture is shown in the accompanying skiagraph. In the colored plate we can see the edema and atrophy of the leg, the atrophy of the thigh, the venous congestion of the leg and foot, and the genu valgum.

Insurance allowance, 20%.

The functional power of the knee was completely restored by the treatment. The skiagraph (Fig. 76) is to be regarded as a mirror-picture.

trivial nature. As a result the tubercle is found thickened, the ligamentum patellæ is somewhat loosened, and the quadriceps shows signs of slight atrophy.

Fractures of the head of the fibula have already been referred to; they are directly produced by kicks or falls, or by the traumatism incidental to a caving-in, or occur indirectly in consequence of falling from a height and landing on the feet, in connection with compression-fractures of the tibia. Sometimes the lesion takes the form of a comminuted fracture. Occasionally the head of the fibula is torn off by the action of the biceps. Healing is characterized by a well-marked growth of callus, by which the bone is left more or less distinctly thickened; the biceps undergoes atrophy, and occasionally is found extremely tense or definitely contracted, causing outward rotation of the leg and outward displacement of the head of the fibula. Severe cases may be accompanied by paralysis of the peroneal nerve, due to its direct injury.

The knee-joint is not affected by isolated fractures of the head of the fibula, except in the unusual instances in which it is in communication with the superior tibiofibular



Fig. 1.



Fig 1^a



Fig. 76.

PLATE 35.

Atrophy of the Left Lower Extremity After a Fracture of the Tibia, Involving the Bony Ridge Anterior to the Inferior Tibiofibular Articulation, and Contusion of the Leg.

The subject of the accompanying illustration was a mason, thirty-eight years of age, who was injured on May 1, 1897, by a beam falling against his left leg. He was at first treated at home, subsequently entering a hospital, where he remained for three weeks. He was a patient in my hospital from February 28, until June 14, 1898, when he was discharged with an insurance allowance of 50%. The atrophy in this case, which involved the whole extremity, was particularly resistant to treatment; the temperature of the foot, including the sole, was reduced. The illustration shows the general atrophy of the limb very well; the affected muscles included the *gluteus medius*, *sartorius*, *quadriceps extensor*, *tibialis anticus*, *gastrocnemius*, *abductor pollicis*, etc. The muscles of the foot are evidently involved as well; even the left heel is smaller than the right, and the impression (Fig. 77) of the sole indicates a similar condition of the muscles in that situation.

joint, when it is likely to share the inflammation of the latter.

Dislocation of the head of the fibula is very rarely seen as a separate lesion; it usually occurs as a secondary effect in cases of fracture of the tibia accompanied by marked displacement of the fragments. Fractures of the head of the fibula are regularly complicated by partial dislocation, due to the action of the biceps.

In one case of forward dislocation of the head of the left fibula which came under my observation I found the knee flexed and the tendon of the biceps very prominent, while the muscle itself was tensely contracted. The peroneal nerve was very sensitive, and movement of the knee was rendered difficult; there was *talipes valgus*, and, in addition, slight atrophy of the muscles of the thigh.

The abnormal position of the head of the fibula in cases of dislocation induces a secondary displacement of the external malleolus and the foot, frequently resembling the displacement due to fracture of the malleolus. This secondary effect on the inferior tibiofibular joint is only slightly marked, if at all, in cases of displacement following fracture of the head of the fibula.



Fig. 1.



Fig. 1^a





Fig. 78.



Fig. 77.

PLATE 36.

Case of Pseudo-arthritis of the Left Leg Following a Compound Fracture.

A roofer, twenty-four years of age, fell from a roof on July 16, 1898, sustaining a compound fracture of the left leg, and, in addition, a contusion of the lumbar vertebrae and a fracture of the ribs. He spent five months in bed in a hospital, and when discharged at the end of that time, the fracture still remained ununited. The point of fracture presented a well-marked angular deformity. He entered my hospital on January 6, 1899. At the time the accompanying illustration was made, in the beginning of February, 1899, there was already some improvement in respect to gait, as a result of medicomechanical treatment and the use of a local support. The picture shows the scar, the displacement, shortening, venous congestion, and atrophy, and, in addition, the diminished size of the foot and the talipes varus. The malposition of the foot is also evidenced in the impressions of the sole. (Fig. 78.) The temperature of the whole extremity was reduced, more especially below the point of fracture. Considerable improvement has since taken place. Figure 1*b* of the plate shows the scar of the leg more in detail. Insurance allowance, when discharged, 50%.

Fractures of the Leg in Its Middle Third and Lower Half.—These fractures are usually due to direct violence, and are met with as a result of many different accidents. Wheels in passing over the leg may break it; it may be struck by heavy falling objects, violently compressed, or, again, may be fractured by a fall from a height, etc.

All varieties of the lesion are seen, from a simple transverse to the most extensive comminuted fracture.

The **symptoms** subsequent to consolidation are as follows:

The bone is thickened at the point of fracture; sometimes the leg, from the knee to the tips of the toes, is swollen and cyanosed; it is shortened and the fragments are displaced forward, backward, or to the sides; the knee and pelvis are lower on the affected side; the muscles of the whole extremity are atrophied and there is difficulty in walking, the patient being obliged to use crutches or a cane for a time. Compound fractures are further characterized by scars and cicatricial adhesions.

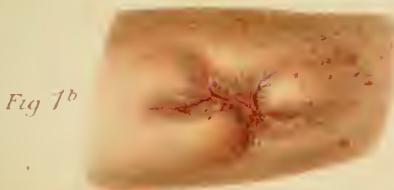




Fig. 79.

Displacement is secondarily manifested in the knee-joint and ankle-joint by a position of valgus or varus or by overextension. Genu recurvatum and talipes equinus or talipes calcaneus are not often seen. Abnormalities of position are displayed in the foot itself, as well as in the ankle-joint and malleoli. Restricted mobility of both knee-joint and ankle-joint is a frequent symptom. Pain is complained of for a long time, especially after exertion or when the weather suddenly changes.

The **treatment** is symptomatic. If the leg is much shortened, a laced shoe with a raised sole should be worn; if the patient is unable to bear his weight on the leg, a removable plaster cast should be tried. These removable casts are constantly in use in my clinic, and render valuable service; they are very light, are easily put on and removed, and frequently take the place of a more expensive support. The leg and whole extremity should be massaged regularly; electricity and baths are also beneficial.

Insurance allowance from 20% to 50%, or more, according to the functional disability. If the patient has to depend on a cane for walking, the rate can not well be made less than 50%. In some cases it can be lowered by supplying the patient with a good supporting apparatus.

Case of fracture of the left leg. (Fig. 79, p. 425.)

A painter, twenty-three years of age, fell from a scaffolding on May 9, 1898, breaking his right leg. He was treated in the hospital until June 10, 1898, and subsequently attended my clinic from July 29, until October 18, 1898. The symptoms, in addition to swelling, were marked thickening at the point of fracture, shortening, and genu valgum. At first there was considerable lameness, but at the time of the patient's discharge this had disappeared, and his gait was excellent. The skiagraph shows the condition of the bone at the time of discharge from treatment. Insurance allowance, 25% until March 10, 1899, when it was entirely discontinued, the patient having fully recovered.

Case of fracture of the left leg due to a fall from a height, in which the fibula healed very slowly. (Fig. 80, p. 427.)

A carpenter, thirty-five years of age, fell from a scaffolding six feet high on October 15, 1894, breaking the left leg in its lower half. The leg was very edematous at first, and was shortened; the knee was over-



Fig. 80.

extended. In addition, the fragments of the fibula failed to unite for nearly a year. The patient was under treatment until December 21,



Fig. 81.

1895; at that time the limb was in a much more normal position. The insurance allowance was at first fixed at 45% ; reduced, after com-



Fig. 82.

plete consolidation of the fibula, to 20%, at which rate it has continued. The man is unable to work at his trade, and has become a cab-driver.

Case of compound fracture of the right leg. Sequels: marked backward displacement; a moderate degree of genu recurvatum; severe functional disability. (Fig. 81, p. 428, and Fig. 82, p. 429.)

A polisher, sixty-three years of age, fell from a scaffolding about six feet high on January 21, 1889, sustaining a compound, comminuted fracture of the right leg. The lower fragments pierced the calf. He was treated at first in a hospital; subsequently at his home, until October 23, 1890. The wound continued to suppurate and fragments of bone to be thrown off for a long time; finally healing took place, leaving scars which were adherent to the bone, both behind, over the calf, and in front, over the tibia. The illustration shows the shortening, the curvature of the bone backward, and the adherent scar over the tibia; also the forward displacement of the foot at the ankle-joint. In the skiagraph the union between the tibia and fibula and the displacement of the bones backward are distinctly displayed. Insurance allowance, 100%. The patient is obliged to use two canes in walking.

Fracture of the leg in its lower-half, followed by marked displacement, genu valgum, and talipes valgus.

A carpenter, forty-four years of age, sustained a fracture of the left leg on August 13, 1891, caused by its being caught between two iron beams. He was treated in the hospital, where the leg was kept in plaster for seven weeks, afterward attending my clinic from November 14, 1891, until January 21, 1892. The leg was much shortened; the lower fragment, together with the foot, was displaced outward to a striking degree, and the bones at the point of fracture were greatly thickened. Genu valgum and talipes valgus were also present. The leg was atrophied. Insurance allowance, 20%. The man is able to do most of the work appertaining to his trade.

The skiagraph (Fig. 83, p. 431) illustrates the case of a workman, thirty-four years of age, who fell out of a second-story window on July 5, 1897, sustaining a severe comminuted fracture of the right leg and fracture of both ankles. On the right side the fracture involved the malleoli, and on the left, the malleoli and the os calcis. The manner in which union took place in the fracture of the leg is beautifully exhibited in the skiagraph. The accompanying picture (Fig. 84, p. 432) shows the bony thickening at the point of fracture. The patient remained in the hospital until August 30, 1897, his course of treatment with me lasting until August 11, 1898. When discharged, he was granted 50% insurance allowance, raised to 75% by the court, at which rate it has continued.

Case of pseudo-arthritis of the tibia and reunited fracture of the fibula. (Fig. 85, p. 433, and Fig. 86, p. 435.)

A mason, thirty years of age, sustained, among other injuries, a fracture of the leg caused by a blow from an iron girder, on October 16, 1889. He was treated in the hospital for a little over one year, being then discharged at his wife's request. A plaster cast was applied for eight weeks, the subsequent treatment consisting of baths and



Fig. 83.

electricity. Figure 85 shows the scar, the point of fracture, the deformity, and the thickening of the bone; also the atrophy of both legs and the shortening of the affected one. The atrophy, especially of the left buttock, is very noticeable in the rear view. In the skiagraph (Fig. 86, p. 435) the pseudo-arthritis, the bony thickening, and the backward displacement of the fragments of the fibula are clearly

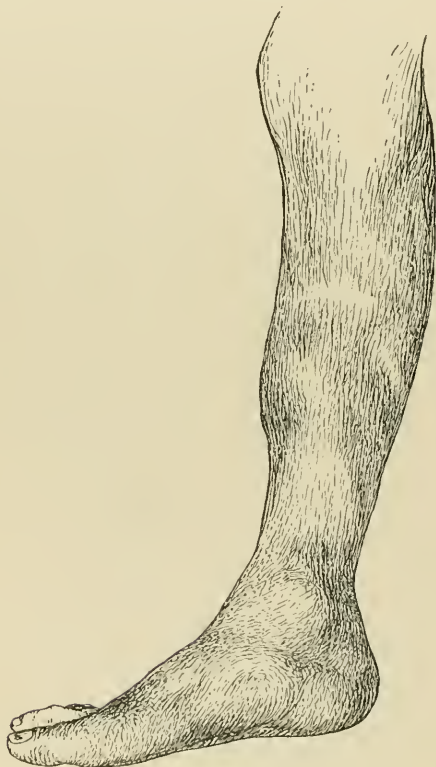


Fig. 84.

visible. The patient wears a supporting apparatus and walks with a cane. Insurance allowance, 100%, partly based on a badly healed fracture of the radius. There has been no improvement up to the present time. The accompanying illustrations were made at the beginning of 1899.

The skiagraph (Fig. 87, p. 436) illustrates the case of a workman, twenty-one years of age, in whom the tibia was broken on June 3,

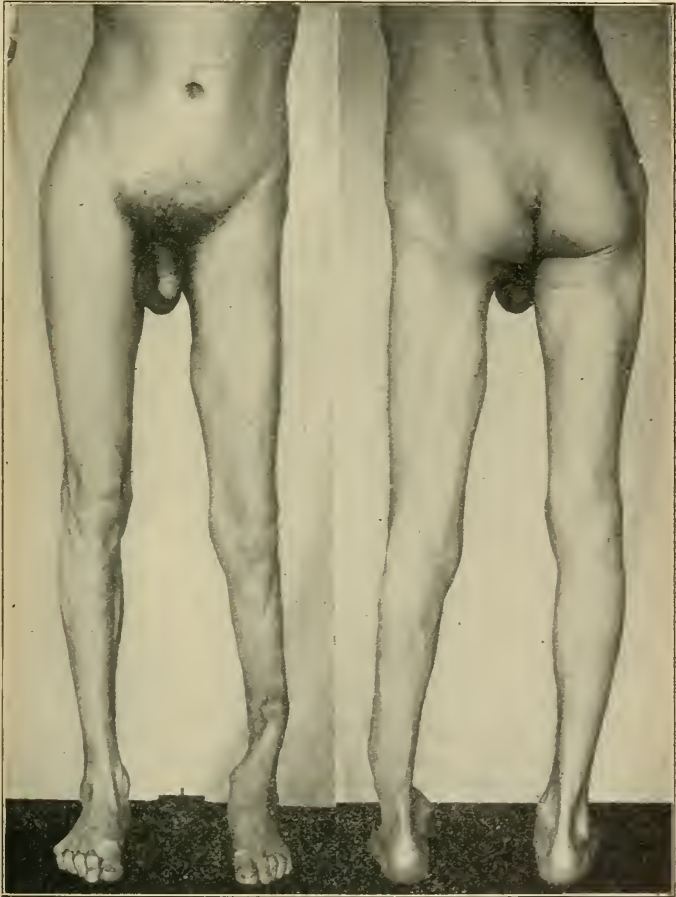


Fig. 85.

1897, by a blow from an iron column which struck it in falling. He was treated in the hospital until September 2, 1897, and subsequently in my

clinic until January 14, 1898. The symptoms were shortening, genu valgum, talipes valgus, swelling, lameness, and atrophy. At the time of the patient's discharge the malposition of the knee-joint and ankle-joint had almost disappeared, the swelling had largely subsided, and the atrophy was only slightly marked. The skiagraph was taken at that time. It was not until a year later that an X-ray examination showed the fracture to be completely healed. The man is now able to do any kind of hard work, and receives no insurance allowance.

Fractures of the Shaft of the Tibia.—These fractures, involving the middle of the bone or its lower half, occur under the same conditions as the fractures of both bones of the leg at these points. The symptoms, too, are very similar; the displacement, however, is usually much less marked. Displacement of the fragments of the tibia causes a secondary malposition of the lower and upper tibiofibular joints, which is likely to interfere with the action of the ankle-joint.

Insurance allowance, from 20% to 33½%, or more. If the patient subsequently regains good use of the leg, and it is only slightly shortened, the insurance allowance is altogether discontinued.

In cases of fracture of the fibula alone, the displacement is most unfavorably manifested at the inferior tibiofibular joint; talipes varus is quite a frequent sequel of the injury.

Fractures of the leg sometimes heal in bad position in spite of careful treatment in the best hospitals. I have collected a considerable number of such cases, of many of which I have taken photographs or skiagraphs or made plaster models. Since poor results are seen even in hospitals in which the most improved methods and appliances are in use, we certainly have no right to jump to the conclusion that the local doctor is to blame when such cases are brought to us from the country. We must remember that he may have had to contend with the conditions most unfavorable to success.

Fractures of the lower third of the leg are quite frequently caused by turning the ankle. The patients are



Fig. 86.



Fig. 87.



Fig. 88.

often found to be sufferers from locomotor ataxia the previous symptoms of which were not sufficiently marked to interfere with their work. We are usually able to observe a rapid development of the disease subsequently to the injury.

The accident also occurs, however, in individuals who are apparently perfectly healthy.

Case of fracture of the right tibia in its lower third caused by turning the ankle and followed by very protracted recovery, complicated by osteomyelitis. (Fig. 88, p. 437.)

A mason, forty-one years of age, slipped and fell to the floor in 1888. A fracture of the tibia was diagnosed, and the patient remained in bed for nineteen weeks. Suppuration took place one year later; a fistula formed and sequestra were thrown off. The patient gradually became able to walk, but could do very little work. Suppuration continued for three years. Subsequently the patient frequently suffered from an inflammatory condition of the scar, which was adherent to the bone. No insurance allowance was granted, as there was no trade-accident involved.

Figure 89, page 439, illustrates a case of reunited supramalleolar fracture occurring in a workman forty-six years of age before the Accident-insurance Law was passed. He remained in bed for four weeks, and two weeks later began to do light work. The fracture was completely consolidated at the end of eight weeks, and gave no further trouble.

Case of reunited fracture of the leg in its lower third, with backward and lateral displacement of the fragments. (Fig. 90, p. 440.)

The lateral displacement is clearly shown in the skiagraph. As a result of this displacement, the malleoli were pushed slightly forward, especially the internal malleolus; the change of position in the external malleolus was somewhat less marked. The leg was somewhat shortened, genu valgum and talipes valgus were also slightly noticeable, and the mobility of both joints was somewhat restricted. Insurance allowance, from May 12, 1899, onward, 25%.

Fractures of the Leg in Its Lower Third in the Vicinity of the Ankle-joint.—These fractures have a direct effect on the position and functional power of the ankle-joint.

1. Supramalleolar Fractures.—Fractures at this point are usually caused by turning the ankle, by falling or jumping from a height, etc.

The *symptoms* are talipes valgus or varus (compare with fractures of the malleoli); shortening of the leg and



Fig. 89.



Fig. 90.

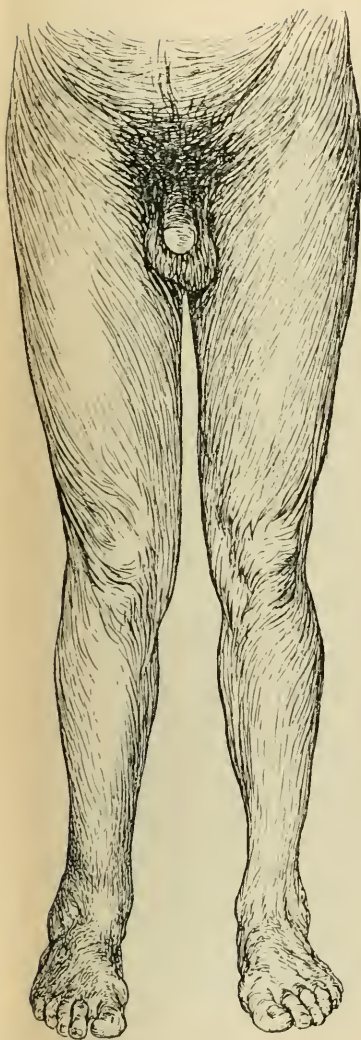


Fig. 91.

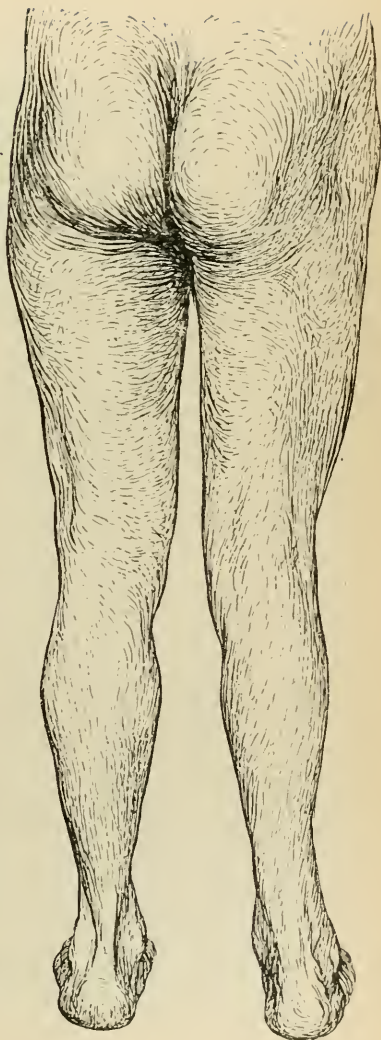


Fig. 92.

thickening of its lower part; atrophy of the whole extremity; edema, and possibly also cyanosis, at first; restricted mobility of the ankle-joint; and difficulty in walking. Supramalleolar fractures may be mistaken for typical fractures of the malleoli.

Figures 91 and 92, page 441, illustrate a case of supramalleolar fracture of the right leg, occurring in a carpenter thirty-nine years of age, who fell from a scaffolding, and in falling was struck on the outer right malleolus by a broken board. The line of fracture of the tibia ran obliquely outward from a point about two fingers'-widths above the internal malleolus. The fibula was broken about a hand's-breadth above the ankle-joint. In the illustration the talipes valgus, the thickening of the leg above the ankle, and the thickening of the tendo Achillis can be recognized; also the atrophy of the whole extremity.

The patient was at first treated in the hospital, beginning a course of medicomechanical treatment on December 18, 1897. He was discharged on August 17, 1898, with an insurance allowance of 50%, reduced, on May 12, 1899, to 20%. At the time of his discharge the patient walked with some difficulty, using a cane. He is now able to do all the regular work of his trade.

Typical case of supramalleolar eversion-fracture of the right leg. (Fig. 93, p. 443.)

A mason, forty-eight years of age, fell to the ground with a broken scaffolding on September 30, 1898. The line of fracture and the typical eversion of the foot are shown in the skiagraph. The patient was under treatment until February 17, 1899, and was obliged to return for subsequent treatment on April 21, 1899. The ankle-joint was almost completely ankylosed, the leg was shortened and atrophied, and there was considerable lameness.

Insurance allowance, 50%.

Severe case of comminuted supramalleolar fracture close to the ankle-joint. (Fig. 94, p. 444, and Fig. 95, p. 445.)

A mason, fifty-one years of age, fell from a room-scaffolding on May 27, 1898. He was treated at first in the hospital, subsequently coming under my care from August 11, 1898, until March 25, 1899, when he was discharged with an insurance allowance of 50%. He was a very tall and stout man, and very flat-footed. The whole right lower extremity was in a state of elephantiasis, while the left leg was also much swollen. The skiagraph (Fig. 94) shows the splintered bones and the displacement from a side view. The ankle-joint was at first completely ankylosed; its mobility, however, was restored by treatment. When discharged, the patient still had to use a cane.

2. Separation of the Epiphyses.—This lesion, occurring at the lower extremity of the bones of the leg, is met with only in young people, as the result of turning



Fig. 93.



Fig. 94.

the ankle in springing from a wagon or from a height, or it may be caused by direct violence, such as a blow from a falling object. The damage is usually repaired quickly and perfectly; in one case coming under my observation, in addition to the separation of the epiphyses, there was a fracture of the fibula, yet the patient, a boy of sixteen,



Fig. 95.

was able to resume work in precisely four weeks from the time of accident.

Compression-fractures of the Lower End of the Tibia.—The cause is the same as of similar fractures of the upper end of the bone. The lesion may occur in connection with a compression-fracture of the os calcis or of a

PLATE 37.

FIG. 1.—Scars Situated in the Popliteal Space, on the Calf, and around the Ankle-joint, with Venous Congestion.

The subject of this illustration, a workman, sixty-two years of age, suffered from a cellulitis of the right ankle and leg, following an abrasion of the skin. The scar in the popliteal space became greatly retracted, and would break open every time the knee was forcibly extended. In consequence of this constant irritation new cicatricial tissue continued to form, causing flexion of the knee. The patient was in my care from March 19, until June 18, 1898, when he was discharged with an insurance allowance of 40%, which he continues to receive. He regained complete ability to extend the knee without causing injury to the scar, but still complains of pain and heaviness in the leg.

FIG. 2.—A workman, thirty-five years of age, was very severely scalded about the legs by boiling water on November 26, 1894. At the same time the boiler containing the water fell upon and crushed his legs, the left leg being more severely injured. The wounds remained open and suppurating for a long time. Skin-grafting was performed, and the patient was under treatment for nearly two years in all. Even after his discharge he was several times obliged to resume treatment.

The illustration shows the extensive scars over the left leg and ankle. The ankle is quite stiff and the patient walks with two canes. Insurance allowance, 90%. During the past year his gait has improved.

vertebra, and it is usually accompanied by fracture of the external malleolus. Subsequent stiffness of the ankle-joint can be avoided by a timely diagnosis and appropriate prophylactic measures. The after-symptoms of the injury are as follows :

The lower part of the leg and the ankle remain thickened, perhaps swollen ; the leg is shortened or the malleoli are displaced ; there may be talipes valgus or talipes varus ; the whole extremity shows signs of atrophy, the mobility of the ankle-joint is restricted and the gait is affected. In one case of compression-fracture of the os calcis and the lower end of the tibia, accompanied by fracture of the external malleolus the patient, a man of forty, and a heavy drinker, was incapacitated for work for a period of nine months.



Fig. 1.



Fig. 2.

Pseudo-arthritis of the Leg.

A false joint may develop after fracture of either one or both bones of the leg. When the tibia is involved, the usefulness of the leg is greatly impaired, although in exceptional cases workmen have been known to do their ordinary work in spite of the false joint.

I once knew a mason—it was, to be sure, before the time of the Accident-insurance Law—who mounted a scaffolding and performed the regular duties of his trade in spite of an unhealed fracture of the tibia. He kept the leg put up in plaster, which he himself properly renewed. After the lapse of two years the bones appeared to the patient to be firmly united. When I examined him, fifteen years later, on the occasion of another injury, I was able to confirm his observation.

Pseudo-arthritis of the leg gives rise to the following symptoms :

A false point of motion is very apparent, both to the physician and to the patient himself. In order to use the leg in walking, the bones must be held in position by a supporting apparatus or a firm bandage, and, in addition, the patient finds it necessary to use a cane. In cases of compound fracture the point of fracture is usually marked by an exostosis, to which the scar is adherent, and which is likely to increase gradually in size. The bones below the point of fracture—in other words, the lower fragment of the leg-bones, including the bones of the foot—are poorly nourished, hence the affected foot is usually found smaller than the other and has a wasted appearance. The leg is also atrophied above the point of fracture, but less strikingly so. The footprint is much reduced in size. For several months the skin of the affected leg remains cyanotic and cool to the touch, especially below the point of fracture. As the cyanosis gradually disappears, the skin becomes abnormally pale; this is most noticeable on the sole of the foot, and is permanent. The temperature of the skin also remains somewhat reduced. If the false joint is situated quite near the ankle-joint,

complete ankylosis of the latter may result. Occasionally pseudo-arthritis is accompanied by a great deal of pain.

Treatment.—When union is delayed, the patient should begin to walk early, the leg being properly supported by a bandage or by an apparatus, while the usual treatment by massage, baths, and electricity is not neglected. Medicomechanical gymnastics should be practised, if possible.

Insurance allowance: The rate is necessarily always high—from 50 % to 60 % or over.

6. INJURIES AND TRAUMATIC DISEASES OF THE FOOT AND ANKLE.

Considerations on Anatomy and Function.—The weight of the body is transmitted from the tibia to the foot, or rather to the astragalus, through which it is conveyed to the bones that rest upon the ground. When at rest, the dorsum of the foot presents a double convexity, and the plantar surface a double concavity. Its shape changes the moment the weight of the body is put upon it; the convexity of the dorsal surface becoming decidedly diminished, while the plantar concavity sinks downward and assumes a simpler form; the outer border of the foot is pressed against the ground, causing the outer arch to disappear. The metatarsal bones and phalanges are pushed forward and are spread out to both sides in fan-shape, making the foot appear longer and broader. The foot in this position is hollowed out underneath, in the shape of a half dome, directed inward, while the two feet, when placed together with their inner borders in contact, form a complete dome.

When the foot changes its shape, under the influence of the weight of the body, as previously described, the ligaments, tendons, and muscles are thereby put on the stretch. This stretching process is limited by the reflex contraction of the muscles, especially of the short muscles of the foot. If the weight which the foot is called upon to support is excessive, or is too suddenly applied, the foot gives way at the point of greatest pressure or of least resistance, and there results a rupture of the ligaments, or a fracture.

The shape of the foot in the different positions which it assumes in walking varies considerably from that which characterizes it in the upright position when standing still. As an illustration, let us, without entering into details, take the position of the foot at one special moment in the series of movements executed in walking—when one foot rests on the ground in front in a position of inversion, the knee of that leg being flexed, while the other foot, with knee extended, is supported on the toes. The shape of the two feet at this moment is very different. The parts of the foot which especially serve to preserve the balance of the body in standing are the posterior

extremity of the os calcis and the heads of the first and fifth metatarsal bones. The action of these three parts accords with the mathematic theory of the preservation of balance by three bases of support.

According to the studies of H. v. Meyers, the arch of the foot finds its chief support anteriorly in the head of the third metatarsal bone, an assumption which he bases on the fact that, if all the other metatarsal bones are removed, the third alone furnishes a sufficient support to the foot in standing. It is undoubtedly true that many individuals, in placing their feet to the ground in walking, bear their weight on the head of the third metatarsal bone. Nevertheless, as I have found from a long series of observations on normal feet, the statement does not at all apply to the majority of normally built people.

The union between the bones of the leg and those of the foot is formed by the astragalus, upon which the tibia rests, and which is clasped on either side by the malleoli. The outer surface of the tibia, just above the trochlear surface of the astragalus, presents a depression extending upward for about the width of two fingers, shaped to correspond to the inner surface of the fibula, with which it here articulates, forming the inferior tibiofibular joint. This is not a joint in an anatomic sense, but it permits of certain movements of the fibula which must be taken into consideration. The external malleolus extends lower down on the astragalus than the internal, and is more movable, thus giving the fibula a range of motion at the ankle-joint greater than that of the tibia. The fibula moves slightly upward when the ankle is flexed, slightly downward when it is extended, and rotates on its long axis during adduction and abduction. The articular surface of the astragalus extends further downward on the external than on the internal surface, reaching nearly to the lower border of the bone, and becoming somewhat convex below, at which point the apex of the external malleolus is closely approximated to it. (See Fractures of the Malleolus.)

The trochlear surface of the astragalus is narrower posteriorly than anteriorly, thus allowing of rotatory movement of the ankle-joint when the foot is flexed on the leg. The capsule of the joint is attached to the margin of the articular cartilage; it hangs loose in front and behind, becoming tense behind when the foot is flexed and tense in front when the foot is extended. An effusion in the joint causes the capsule to bulge. Laterally, the capsule is reinforced by the internal and external lateral ligaments respectively. The external ligament consists of three separate bands, the interval between them marking weak points in the capsule, at which it bulges in case of effusion, and where a communication with the posterior calcaneo-astragaloid articulation may possibly be formed. The internal lateral ligament (deltoid ligament) is much stronger than the external, and forms a continuous, firm, fibrous band, closely adherent to the capsule of the joint, which is attached above to the lower border of the internal malleolus and broadens out below to be inserted into the astragalus and os calcis, sending a prolongation forward under the inferior calcaneoscaphoid ligament, to which it is attached, to the scaphoid bone. Laceration of this ligament unavoidably opens the ankle-joint.

Immediately under the inferior calcaneoscaphoid ligament lies the strong tendon of the tibialis posticus muscle, which is inserted into the tubercle of the scaphoid.

The mobility of the foot chiefly depends on the ankle-joint proper.

The following movements are executed at the ankle-joint.

1. *Dorsal flexion.*—*Flexion.*—The dorsum of the foot is drawn toward the leg, forming an acute angle. Starting from the position of a right angle, the range of flexion possessed by the foot equals about 25 degrees. The transverse diameter of the ankle is greatest in the flexed position, showing the malleoli to be then most widely separated. Rotation can not take place in this position. The ligaments connecting the tibia and fibula posteriorly are out on the stretch. The muscles concerned in flexion are the tibialis anticus and peroneus tertius (supplied by the anterior tibial nerve).

2. *Plantar flexion.*—*Extension.*—The dorsum of the foot is drawn away from the leg, forming an obtuse angle. The range of extension, the starting-point being the same as for flexion, equals about 35 degrees. In this position the malleoli clasp the narrowest portion of the trochlear surface of the astragalus and the transverse diameter of the ankle-joint is diminished; the lower ends of the tibia and fibula are therefore brought into closer apposition. The inferior anterior ligament connecting them is relaxed. This position allows of rotatory movements. Extension is produced by the gastrocnemius and soleus through the medium of the tendo Achillis (internal popliteal nerve).

Flexion and extension take place around the same axis passing through the trochlea of the astragalus. The extreme of both movements is accompanied by movement in the calcaneo-astragaloid and mid-tarsal joints.

3. *Adduction.*—The tip of the foot is drawn inward to an angle of about 45 degrees. During adduction the internal malleolus moves slightly backward and the external slightly forward; the transverse diameter of the malleoli is diminished, the inferior tibiofibular ligaments are put on the stretch, and the deltoid ligament becomes relaxed. Adduction is accompanied by inversion of the foot, and is produced by the tibialis anticus (anterior tibial nerve) and tibialis posticus (posterior tibial nerve).

4. *Abduction.*—The tip of the foot is drawn outward, to an angle of about 50 degrees. During this movement the internal malleolus moves slightly forward on the astragalus, and the external slightly backward. The transverse diameter of the malleoli is increased, the deltoid ligament is put on the stretch, and the anterior inferior tibiofibular ligament is relaxed. Abduction is accompanied by eversion, and is executed by the peroneus longus and peroneus brevis (supplied by the peroneal nerve).

The axis of rotation in adduction and abduction remains vertical up to the point marking the commencement of inversion and eversion of the foot. The two latter movements take place in the mid-tarsal joint, while the ankle-joint is fixed. Adduction and abduction, or inversion and eversion, are therefore really rotatory movements.

5. *Circumduction*, made up of all the four, or rather six, preceding movements, in which the tip of the foot describes a circle.

Movement of the toes is limited to flexion and extension, except in the case of the metatarsophalangeal joint of the great toe, which allows of a very slight degree of adduction and abduction.

Walking is rendered difficult or impossible and the usefulness of the whole limb is more or less destroyed by deformity or stiffness of the foot and ankle following traumatism or disease.

Sprains of the Ankle-joint.

(299 Cases.)

It is only of recent years that the medical profession has begun carefully to distinguish between true sprains and the injuries which formerly were mistakenly diagnosed as "sprains," such as supramalleolar fractures, fractures of the malleoli, and fractures of the os calcis or astragalus. Even at the present day such mistakes are made only too often.

One of the most striking of the after-symptoms of sprains of the ankle-joint is weakness of the joint, which is easily accounted for by the strain or laceration of the ligaments regularly accompanying the lesion. In addition, we find the ankle-joint swollen and painful, the joint-capsule swollen, and the muscles atrophied. Usually, only the muscles of the leg are affected; occasionally, the process involves the whole extremity.

In cases of slight and moderate severity recovery usually takes place in a short time.

Insurance allowance, up to 20%, or more in severe cases.

There is a typical form of severe sprain, in which healing progresses very slowly, and of which the unfavorable results are very persistent, causing a relatively high rate of incapacity for work.

The cause of these sprains is to be sought in the usual accidents—a misstep, turning the ankle by stepping on a small stone, alighting on the feet after a fall or a leap and turning the ankle. The only point of difference lies in the degree of violence. The severe sprains in question involve a distinct partial dislocation of the ankle-joint

and mid-tarsal joint, in addition to the usual injury to the ligaments. By means of the X-rays we are able to determine the exact extent of the displacement. External examination shows an abnormal position of the external malleolus ; it appears thickened, as if it had been the seat of a fracture, a resemblance which is heightened by the fact that the transverse diameter of the ankle-joint is shown by measurement to be increased. Not infrequently we find the internal malleolus thickened also and its outlines indistinct. In the majority of cases the foot is slightly inverted ; less frequently it is slightly everted.

In the former case a careful examination, made with the feet placed parallel, will show the external malleolus of the affected foot to be displaced slightly backward ; if, on the contrary, the foot be everted, the malleolus is usually found to be displaced forward, its posterior border is turned slightly outward, and the tendons of the peronei muscles are very prominent. If, now, we examine the patient by the X-rays, we find the fibula to be separated from the tibia at the inferior tibiofibular joint, so that it is proper to speak of a subluxation of this joint. The shaft of the fibula is in some cases closely approximated to the tibia, while in others the interval between the bones is increased ; the anterior extremity of the os calcis is frequently displaced upward at the calcaneocuboid joint, the head of the astragalus also lies higher than normal ; in other words, there is a subluxation of the mid-tarsal joint. The displacement of the external malleolus often affects the whole fibula, even to the head of the bone.

As already stated, we find the foot inverted in the majority of cases of sprained ankle, which is doubtless due to laceration of the anterior ligamentous connections between the tibia, fibula, and astragalus, or to fragments having been torn off these bones. The backward displacement of the external malleolus naturally causes a certain degree of outward rotation of the astragalus ; the os calcis, too, is slightly rotated outward on its long axis,



Fig. 96.

PLATE 38.

Case of Atrophy of the Back and Sole of the Foot after a Fracture of the Os Calcis.

A workman, twenty-four years of age, fell from a scaffolding one story high on August 16, 1898, sustaining a fracture of the left os calcis. He was treated at first in the hospital, then attended my clinic from October 22, 1898, until April 20, 1899. The illustrations show the atrophy of the muscles of the left foot very distinctly. The abductor pollicis and the belly of the extensor communis brevis are particularly affected. The toes appear more closely approximated than on the normal foot; the sole is narrowed, and is somewhat pale or livid in color. The plantar fascia, which normally can be distinctly traced, is not evident on the atrophied foot. The reduced size of the footprint and the slight flattening of the arch are shown in figure 97.

making it appear thickened externally, as if it had been the seat of a compression-fracture. The position of the astragalus naturally affects that of the tibia, and we therefore find a subluxation of the ankle-joint. The tibia is slightly rotated outward, the knee on the injured side is in some cases slightly raised above the normal, the same change of position being apparent at the anterior superior spine. The muscles appear atonic, or even greatly atrophied. This is most noticeable in the leg, but may involve the whole extremity. The inversion of the foot necessitates walking on its outer edge; the metatarsal bones are thereby pressed closely together, narrowing the foot.

Case of sprained ankle, complicated by dislocation of the inferior tibio-fibular joint. (Fig. 96, p. 453.)

A workman, forty years of age, slipped on a ladder on January 25, 1898, and fell from the fourth rung, spraining his ankle. He was treated in the hospital for seven weeks; splints were applied for two weeks and plaster bandages for four weeks; he was allowed to walk in the eighth week. He was subsequently treated in my clinic, up to October 14, 1898. The swelling of the ankle subsided very slowly, and the patient remained lame for a long time. The skiagraph shows the upward displacement of the head of the astragalus and the anterior extremity of the os calcis; also the backward displacement of the external malleolus. The foot was inverted.



Fig. 1.



Fig. 1^a



Fig. 2



Fig. 2^a

In slight cases of sprain the usefulness of the part may be only impaired slightly, or not at all. Patients are usually able to walk without difficulty in five or six weeks, although they continue to complain of pain, which they definitely locate in the ankle-joint, and of inability to carry heavy loads.

The effect on functional power of severe cases of sprain is, on the other hand, very considerable. Lameness is a marked symptom, and the muscles of the whole extremity, and especially of the foot, become greatly atrophied. It may be six months, or even longer, before the patient is able to resume work.

Treatment.—The malposition of the foot should be corrected by careful bandaging, or the patient should wear a laced shoe, appropriately padded. In addition, medico-mechanical exercises on an apparatus, massage, electricity, etc., are in place.

Insurance allowance, 20%. If the patient is obliged to use a cane, 50% or over.

Apart from the typical displacement of the ankle in cases of sprain (including the mid-tarsal joint), we occasionally see cases in which the appearances simulate a fracture of the internal malleolus, although the latter is quite intact. The internal malleolus projects distinctly and its outlines are not well defined; as a rule, there is no talipes valgus. If a skiagraph be taken with the toes pointing upward, it will show an abnormally wide interval between the articular surface of the internal malleolus and the internal surface of the astragalus. Having found the external malleolus abnormally movable in a number of these cases, I conclude that the malposition is due to laceration of the external lateral ligament of the joint. Patients are usually able to resume work within a few weeks. A firm bandage around the ankle will be found very helpful, especially during working hours.

When an insurance allowance becomes necessary, a rate of from 10% to 20% will usually be found sufficient; it

seldom needs to exceed this. Complete recovery is to be expected within six months in average cases.

Dislocation of the Ankle-joint.

Subluxations of the ankle-joint proper and of the calca-



Fig. 97.

neo-astragaloid and mid-tarsal joints have been discussed under sprains.

Dislocations of the ankle-joint, if properly reduced, should heal without difficulty, and leave no after-trouble; but in some cases unfavorable results are seen. These usually take the form of loose-jointedness, or of stiffness and restricted mobility of the ankle-joint. The latter

condition is due to cicatricial adhesions, contractures, or displacement. Movement of the joint is painful and produces crepitus, and the muscles of the foot and leg, or even of the whole extremity, undergo atrophy.

The **treatment** is symptomatic. Insurance allowance, about 20 %.

Lateral dislocations are usually complicated with fractures of the malleoli, hence the similarity of the after-symptoms of the two lesions, as displayed in talipes valgus or varus, flexion of the knee, stiffness of the joint, and muscular atrophy.

Dislocation of the Astragalus.

One form of lateral dislocation of this bone, which is more properly spoken of as a subluxation, is apt to remain unrecognized, and to be seldom, if ever, reduced, although even after the acute symptoms have subsided the displacement remains quite noticeable. The injury is diagnosed as "dislocation" or "sprain" of the ankle-joint, or occasionally as a "malleolar fracture." As a rule, the astragalus is displaced inward, the inner edge of the trochlear surface, as well as the neck and head of the bone, being distinctly perceptible on the inner border of the foot. There is a slight degree of talipes valgus, and the outlines of the external malleolus can barely be discerned. Flexion and extension of the ankle-joint are relatively well preserved, but lateral movement is restricted. The muscles of the calf are usually found atrophied. It is often necessary for the patient to wear a laced boot with an appropriate pad; in especially severe cases side supports may also be required.

Insurance allowance, from 20 % to 25 %, on the average.

Subluxation of the whole bone outward, with consequent talipes varus, is also met with, but less frequently than the form previously described, and usually occurs in

connection with a fracture of the external malleolus or shaft of the fibula.

Unreduced dislocations of the astragalus lead to serious functional disability, which is all the more marked if the lesion is complicated by a fracture. (Compare with Fractures.)

Symptoms.—The deformity of the foot, especially at the ankle, is very striking; the leg is shortened or lengthened according to the form of dislocation; the ankle is stiff, there is talipes valgus or varus, and the muscles of the whole extremity show signs of atrophy. Lameness is a marked symptom.

Treatment.—Reduction should be performed by operation.

Insurance allowance, usually 50 % or more.

Dislocations of the astragalus, when properly reduced, usually leave the joint in good condition. Adhesions, however, sometimes produce ankylosis, and lead to muscular atrophy.

If the head of the astragalus is forced through the soft parts and skin, making a compound dislocation, there is, of course, the added danger of infection; even if this is happily avoided, the subsequent stiffness is increased by the presence of an adherent scar.

Other unfavorable cases are followed by loose-jointedness.

Typical Fractures of the Malleoli.

(412 Cases.)

Eversion-fractures, in which the fibula is fractured just above the external malleolus, and the internal malleolus is torn off by the tension of the deltoid ligament, are caused by the ankle being violently turned inward, the foot thus being everted and carried outward. The deformity characteristic of these fractures is a marked feature, even after consolidation takes place.

Symptoms.—At the time when the patient is dismissed from surgical treatment he is usually lame, and may be unable to walk at all without the support of one or even two canes. The injured foot and leg are congested and edematous, reddish-blue in color, and frequently extremely cold to the touch. The whole extremity, from the buttocks down, is noticeably atrophied. The foot often appears small, and narrowed across the toes and metatarsus in consequence of the atrophy of the muscles; while the sole is soft, thin, and pale or slightly cyanotic. If the patient is placed on a high stool, with the feet parallel, the internal malleolus is seen to be much thickened and to project considerably; it is also somewhat directed downward. The external malleolus appears flattened and is raised in proportion as the inner one is depressed. Just above it a distinct depression is noticeable. In many cases the internal malleolus is found displaced forward, the external malleolus being displaced backward to a corresponding degree; consequently, the inner border of the dorsum of the foot is more or less shortened. The astragalus, having lost the support of the deltoid ligament, sinks somewhat downward and inward, carrying the scaphoid with it. In short, we have a rotation of the foot by which its inner border is lowered and its outer border correspondingly raised. The articular surface of the tibia frequently becomes partly displaced from the trochlea of the astragalus, and the mobility of the ankle-joint is restricted or completely suspended. Of the movements of the joint, flexion and extension are relatively best preserved, lateral movement being much more seriously affected. There is often distinct crepitus under the malleoli perceptible to the touch, and sometimes loud enough to be heard at a distance. Lameness is a more or less well-marked symptom, and frequently depends not only on the deformity of the foot as previously described, but also on the malposition of the knee-joint and hip-joint that accompany it. This con-

sists of genu valgum, together with flexion and inward rotation of the leg, and inward rotation of the head of the femur.

The after-treatment for these typical malleolar fractures

may extend over several months, or even a whole year if the individual is no longer young. A laced and padded shoe should be worn to prevent an increase of the deformity. Splints, by relieving the foot of the weight of the body, sometimes render excellent service, and effect a more rapid cure than could otherwise be accomplished. If the valgus is extreme and the patient is very stout, it is well to strengthen the inner bar of the splint by a small horizontal bar running from it to the heel. This also adds considerably to the support of the foot. Massage, electric stimulation of the muscles, and medico-mechanical exercises are also of great value. Insurance allowance, from 25% to 33%, or more, depending on the deformity.

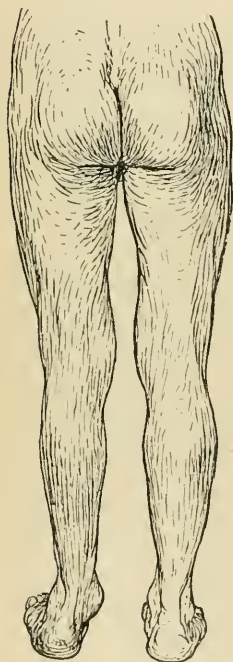


Fig. 98

The accompanying picture (Fig. 98) illustrates the case of a workman, thirty-four years of age, who sustained a typical eversion-fracture of the internal malleolus caused by a wheel passing over his left ankle. The inner malleolus is thickened

and very prominent, the foot is displaced outward, and the muscles of the whole extremity, especially of the leg, are atrophied.

Case of typical eversion-fracture of the internal malleolus, followed by serious functional disability.

The accompanying skiagraph (Fig. 99, p. 461) shows the condition of the injured parts in the case of a workman, forty-nine years of age, who was injured, as just stated, on July 3, 1897, when a cart loaded with stones struck his right leg. He was treated in the hospital for



Fig. 99.



Fig. 100.



Fig. 101.

ten weeks, beginning to walk six weeks after the accident, the ankle being properly supported.

I examined him on October 2, 1897. The deformity is sufficiently shown in the skiagraph. He walked on the inner border of the foot, and the ankle was extremely stiff. He was discharged from treatment on February 22, 1898, with an insurance allowance of 33½%. The gait had considerably improved. There is no further change to be reported.

Case of typical eversion-fracture of the internal malleolus. (Fig. 100, p. 462.)

A druggist, thirty-two years of age, when discharging a commission in a new building, fell with a scaffolding, and at the same time his left ankle was struck by a board. The illustration shows a well-marked talipes valgus; the foot is much displaced outward; the internal malleolus is extremely prominent. The ankle was stiff at first, but after a course of treatment its mobility was satisfactorily regained. The patient was sufficiently recovered to be on his feet from early in the morning until late in the evening a year after the accident. His insurance allowance was 30% at first but was reduced to 15% in the following year. The whole extremity has remained considerably atrophied, and varicose veins are beginning to show in both legs.

The accompanying skiagraph (Fig. 101, p. 463) shows a very severe case of typical eversion-fracture of the left ankle, with subsequent complete ankylosis. The patient was a painter, forty-five years of age, who sustained the injury in question by falling down a flight of stairs on July 27, 1896. He was under treatment until April, 1897, when he was discharged with an insurance allowance of 33½%. He was exceedingly lame at first; this symptom somewhat diminished later on. No important change has taken place in his condition. The skiagraph was taken shortly before his discharge.

The typical inversion-fractures of the external malleolus are produced, as are many sprains, by violently turning the ankle with the foot inverted. The outer edge of the trochlea of the astragalus strikes against the inner surface of the external malleolus, and, as the external lateral ligament is usually strong enough to resist the strain, the malleolus is broken off just above the border of the astragalus. In some cases, however, the ligament gives way also. The mechanism of the lesion is too well known from text-books on fractures and dislocations to need discussion here. It often passes unrecognized under the diagnosis of "sprain." Since working-men are sometimes known to continue to use the injured foot after the accident,—walking to the doctor or remaining at their

work,—trades-unions are often inclined to discredit the existence of a fracture and to fix the rate of insurance allowance proportionately.

The sequels depend altogether on the accuracy of the diagnosis and on the treatment that is instituted. If the injury is regarded as a simple sprain, requiring only rest and applications, healing is likely to be accompanied by extensive callous thickening of the external malleolus, and by more or less well-defined inversion of the foot. The latter is a marked feature of some cases, especially of those accompanied by the characteristic displacements of sprain and by dislocation of the inferior tibiofibular joint. Occasionally, the fragment of the malleolus is carried downward and slightly backward by the calcaneo-fibular division of the external lateral ligament, leaving an appreciable interval between it and the upper fragment.

Even when diagnosis and treatment are all that could be desired, cases sometimes occur presenting a well-defined talipes varus after recovery.

In contradistinction to this fact excellent results are sometimes obtained in spite of continued use of the injured foot and an entire lack of treatment, or, at the most, a bandage around the ankle.

The talipes varus is explained by the change of relation between the astragalus and the external malleolus, as well as between the former and the other adjacent tarsal bones, and made still more clear by an X-ray examination. The deformity of the foot obliges the patient to tread more or less on its outer border; it grows thinner and narrower; the metatarsal bones change their position in adapting themselves to the new conditions from above; the whole extremity, even including the buttocks, undergoes atrophy, and genu varum, or occasionally valgum, is frequently observed. Crepitus under the external malleolus persists for some time, and mobility of the joint is restricted. Lameness is usually evident for a time after healing of the fracture.

The after-treatment consists of local vapor-baths and medicomechanical exercises, by means of which the symptoms are gradually overcome. The malposition is best opposed by a properly padded laced shoe. Patients are able to resume work, as a rule, within from four to six weeks, although cases are not lacking in which six months and even longer are required for treatment. The usefulness of the joint may be partly or even completely restored, while its general anatomic condition remains as previously described. Recovery, in the sense of complete disappearance of all the symptoms, may, indeed, never take place.

Average insurance allowance, 20%; for severe cases, 33 $\frac{1}{3}$ % or more.

Occasionally, in cases of eversion-fracture, a bit of the tibia is broken off from the outer part of its lower extremity at the same time that the fibula is fractured just above the malleolus. The injury to the tibia at this point increases the danger of subsequent stiffness of the ankle-joint.

Case of typical inversion-fracture of the left ankle (fracture of the external malleolus). (Figs. 102 and 103, p. 467.)

A carpenter, thirty-nine years of age, fell from a scaffolding, about nine feet high, on November 21, 1890, sustaining the fracture just named. When I examined him, on February 24, 1891, he complained of pain in the outer side of the ankle, running up to the middle of the knee. The external malleolus was much thickened, the internal one had disappeared. The foot was inverted and the tendon of the tibialis anticus was strongly contracted. The muscles of the whole extremity were atrophied; the left anterior superior spine and the knee-joint and ankle-joint were elevated. The last-named symptoms disappeared in the course of time. The ankle-joint was partly stiff, and there was crepitation under the external malleolus on movement of the joint. The accompanying illustrations show the inversion of the foot and the thickening of the external malleolus; the foot also appears narrowed and the leg wasted. The skiagraph showed the fibula to be considerably displaced; the lower extremity was separated from the inferior tibiofibular joint, while the fibula, as a whole, which had become somewhat curved subsequent to the fracture, was closely approximated to the tibia. The course of treatment lasted from February 24, 1891, until August 14, 1891. At first lameness had been very marked, and the patient had been unable to walk without a cane; when discharged, he was able to walk much better.

Insurance allowance, 33 $\frac{1}{3}$ %, reduced to 20% on December 8, 1896.

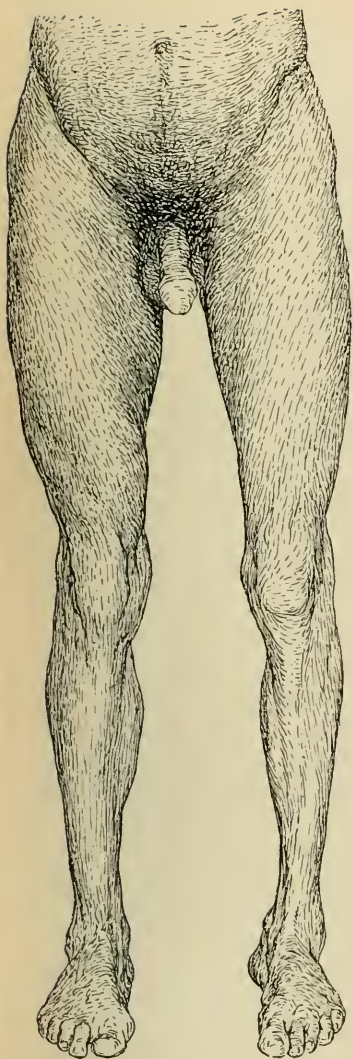


Fig. 102.

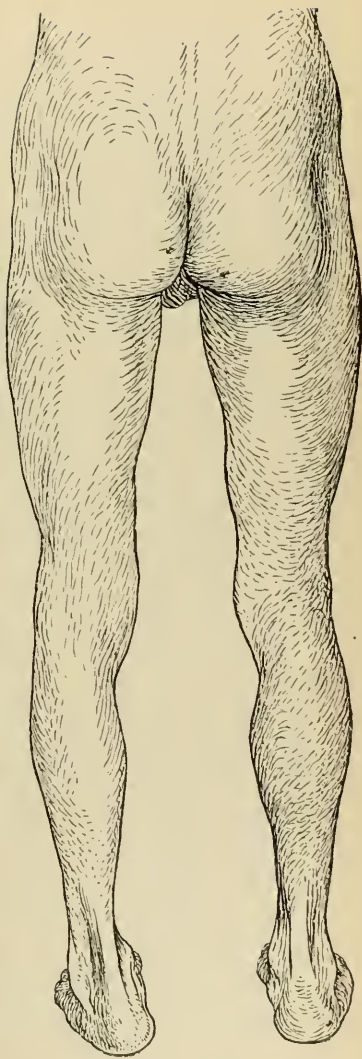


Fig. 103.

Uncomplicated Fractures of the Malleoli.

It still remains to speak of fractures of the malleoli alone, uncomplicated by fracture of the shaft of either the tibia or fibula.

These fractures are produced by a fall or leap from a height, by turning the ankle, etc. One or both malleoli may be involved. Very frequently the fracture remains unrecognized, being diagnosed as a sprain, and sometimes the patient simply binds a handkerchief around the injured ankle and continues to work, or proceeds on foot to the doctor.

Symptoms after healing of the fracture: The ankle remains swollen, the outlines of the malleolus appear indistinct, the depressions on either side of the tendo Achillis are filled in, pressure on the affected malleolus is likely to be painful and there is pain on moving the ankle and in walking. Crepitus may develop somewhat later, and the muscles of the foot and leg, and possibly of the whole extremity, undergo atrophy.

Average insurance allowance, 20 %.

Fractures of the Ankle-joint.

The first class of these fractures to be considered is that in which the whole ankle-joint is involved, or, in other words, in which both the lower extremity of the tibia and the trochlear surface of the astragalus are involved.

Causes.—Falling or leaping from a height, from a vehicle, or from a ladder; severe crushing—caving in, being run over, etc.

Symptoms after union is established: The ankle-joint remains swollen and thickened; the leg is shortened; there is talipes valgus or varus; the foot is displaced forward or backward; the ankle-joint is stiff; the muscles are atrophied, and the patient is lame.

Treatment.—This is directed toward the recovery of mobility, and includes local baths, massage, gymnastics, and electricity.

Insurance allowance, from 30 % to 50 %.

Fractures of the Astragalus.

Whether the fractures of this bone involve the body or the processes is determined by the form of violence as well as by its intensity.

The body of the astragalus is formed of very dense cortical substance, and in the great majority of cases a leap or fall from a height on the feet causes it to be driven into the spongy tissue of the os calcis. In other cases the body of the astragalus alone is fractured. It may be fissured or broken into fragments.

Fractures of the body may be confined to this portion of the bone or may extend into the processes or to the os calcis. The functional prognosis of ordinary longitudinal fissures of the trochlea is good; comminuted or multiple fractures of the body, on the other hand, invariably leave the joint stiff.

The **symptoms** are as follows: The leg is shortened; the whole ankle is swollen or thickened, making the outlines of the malleoli indistinct. In place of the usual concave curve of the ankle-joint in front, we find a prominence at this point between the back of the foot and the leg; the tarsal sinus appears swollen and is the seat of pain (tarsalgia); the convexity of the posterior portion of the dorsum of the foot is increased; the foot is atrophied, as is the whole extremity, and the patient is lame. Insurance allowance, from $33\frac{1}{3}$ % to 50 %, or more.

Fractures of the astragalus are frequently accompanied by dislocation, which is likely to produce an extreme degree of club-foot, almost destroying its usefulness. (See Plate 40, Fig. 2.)

Symptoms.—If the tibia rests on one or both margins of the trochlea, the extremity is lengthened; otherwise it

is shortened. There is club-foot or flat-foot, sometimes accompanied by talipes valgus. The length of the back of the foot is diminished or increased, the hollow at the ankle is filled in and painful; the ankle-joint is stiff; the muscles are atrophied, and the patient finds it difficult to stand or to walk. If the extremity is lengthened, the patient is unable to place the feet parallel, and has to put the injured one in front.

Insurance allowance, usually over 50 %.

Fractures of the Neck and Head of the Astragalus.

These lesions are met with far more frequently than fractures of the body, which is partly to be accounted for by the preponderance of spongy tissue in the neck of the bone. Fractures of the neck are caused not only by such accidents as a fall or leap from a height, but also by much simpler forms of traumatism, such as turning the ankle, especially when the foot is caught. The remote symptoms depend on the position in which the fragments unite. If the head of the bone is displaced upward, the dorsum of the foot appears abnormally arched and prominent. If it is displaced inward, talipes valgus or varus results, more often the latter. One form of fracture of the neck deserves special attention,—namely, compression-fracture,—in which the violence acts in the long axis of the foot. This form is probably never met with except in cases of caving-in.

My collection includes a specimen of reunited compression-fracture of the neck of the astragalus, the scaphoid also showing evidences of compression. I also once happened to see a reunited compression-fracture of the neck of the astragalus in a subject in the dissecting-room.

Case of reunited fracture of the neck of the astragalus, of the tubercle on its posterior surface, and of the os calcis, caused by turning the ankle. Sequel, complete ankylosis of the ankle-joint.

A hod-carrier, twenty-seven years of age, when carrying a load of lime on his shoulder, stepped on a small stone and turned his ankle. He sustained the injuries just mentioned, in addition to a sprain. He was treated in the hospital at first, coming to me for a course of after-



Fig. 104.

treatment on December 27, 1890. The injury had been followed by a suppurative inflammation of the ankle-joint, and as, in addition, the operation-scars were very slow in healing, the course of treatment was much prolonged. The patient was discharged on December 18, 1891.

The accompanying skiagraph (Fig. 104, p. 471) shows very distinctly the line of fracture on the neck of the astragalus; the fracture of the os calcis and of the posterior tubercle of the astragalus are less plainly visible.

Insurance allowance, 30%, which the patient still continues to receive.

Case of fracture of the os calcis and neck of the astragalus due to a fall from a second-story window. (Fig. 105, p. 473.)

A painter, twenty-three years of age, sustained the foregoing injuries on June 7, 1894, and, in addition, a typical fracture of the radius and a fracture of the vertebrae.

The accompanying skiagraph (Fig. 105) shows the line of fracture on the os calcis, although not very distinctly; the exostosis on the neck of the astragalus is more plainly to be seen.

The course of treatment, partly on account of the various complications, lasted until April 25, 1895,

Total insurance allowance, 50%. The patient works at his trade, but his working capacity is limited.

After consolidation of fractures of the neck of the astragalus we find, on palpation, a thick, hard, ring-shaped mass in front of the ankle-joint, especially noticeable in cases in which the head of the astragalus is displaced upward. The ankle appears greatly swollen, and is likely to be quite stiff. This is, however, not necessarily the case, unless the lesion occurs in connection with a fracture of the malleoli. The talipes valgus or varus is often accompanied by deformity of the flat-foot or club-foot variety. In cases of fracture of the neck due to compression in its longitudinal axis we find the foot shortened. Fractures extending through the head of the astragalus lead to ankylosis of the astragalo-scaphoid joint, thereby restricting or abolishing the movements of inversion and eversion of the foot.

Case of comminuted fracture of the neck of the astragalus. (Fig. 106, p. 474.)

A painter, twenty-one years of age, fell from a third-story window on July 22, 1896, sustaining, among other injuries, a fracture of both ankles. The accompanying skiagraph shows the fracture of the neck of the left astragalus. The patient was at first treated in the hospital,



Fig. 105.



Fig. 106.

and subsequently received treatment under my direction from October 20 until December 12, 1896. The skiagraph was taken at the time of his discharge. There was a decided talipes varus, but the patient was comparatively little inconvenienced thereby, and could walk quite well.

The after-treatment of fractures of the astragalus may demand considerable time, particularly when, by reason of a mistaken diagnosis, the patient was allowed to walk too soon. This is unfortunately not so infrequent an occurrence as one would wish.

A laced boot, possibly with side supports, is in many cases essential at first. Exercise, massage, etc., to overcome the stiffness, are, of course, also indicated.

The insurance allowance may amount to from 25% to $33\frac{1}{3}\%$; in severe cases a considerably higher rate may be warranted.

The posterior internal tubercle of the astragalus is very frequently broken off. This tubercle contains a groove that affords passage to the tendon of the flexor longus pollicis, while the tendon of the flexor communis digitorum runs along its border. The lesion is very likely to occur in connection with compression-fractures of the os calcis, in which the astragalus becomes impacted in the former bone. Occasionally, the fracture is confined to the process, in which case it is due to turning the ankle, usually to turning it inward, the foot being forcibly everted. Sometimes the tubercle is not only broken off, but is displaced by nearly one centimeter toward the posterior extremity of the os calcis.

The lesion can subsequently be recognized by a swelling or prominence behind the internal malleolus, which is most apparent when the feet are placed parallel and viewed from behind. This point is usually sensitive to pressure. Flexion of the great toe is sometimes interfered with.

When only the tubercle is involved, the patient is usually not incapacitated for work. An insurance allowance of 15% for three months is usually sufficient for the

cases in which the symptoms consist of slight swelling, slight talipes valgus, partial inability to flex the toes, and moderate muscular atrophy of the leg.

It should be remembered that fractures of the astragalus are very often overlooked, and are frequently difficult to diagnose. They are often concealed under the diagnosis of "sprain" or "malleolar fracture."

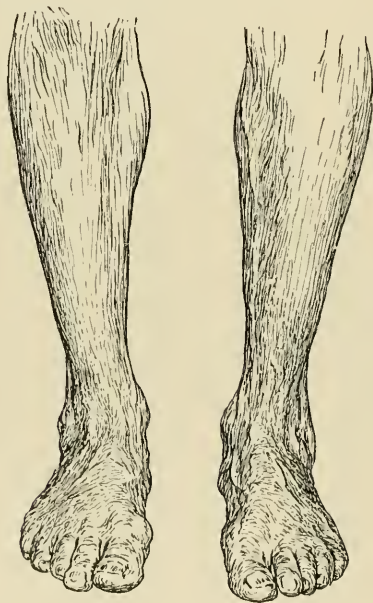


Fig. 107.

Scars of the Ankle.

Extensive scars over the ankle, or scars in this location which are deeply attached to the underlying tissues, have an extremely unfavorable influence upon the circulation of the foot and upon the action of the joint. The latter may be completely immobilized; the foot becomes atrophied,

and the foot and leg appear congested. Scalds, followed by prolonged suppuration, and cellulitis are the chief causes of such extensive growths of cicatricial tissue. The insurance allowance varies from 25% to 50%, according to the severity of the symptoms.

Dislocation of the Peronei Tendons.

The peronei tendons are occasionally displaced in connection with sprains of the ankle, fractures of the external malleolus or fractures of the tubercle on the external surface of the os calcis. It is rare for the dislocation to occur by itself. If there is much pain, the tendons should be sutured in position; sometimes, however, the displacement gives rise to no trouble whatever. After fractures of the external tubercle on the os calcis, there is danger of the tendons becoming involved in the callus, in which case the action of the muscles is abolished. (See Separation of the Tubercle on the External Surface of the Os Calcis.)

Case of partial dislocation of the tendon of the peroneus longus, due to fracture of the os calcis.

By looking closely at the accompanying illustration (Fig. 107) the tendon of the peroneus longus can be recognized above the external malleolus. The displacement gave rise to no symptoms in this case.

Traumatic Achillodynia.

This term indicates an inflammation of the bursa just above the insertion of the tendo Achillis, lying between it and the posterior extremity of the os calcis. In some cases the symptoms are inconsiderable; in others, the patients complain of very severe pain. Suppuration may be induced by irritating pressure of the shoe.

Wounds and Scars of the Foot.

(Fifty-seven Cases of Wounds of the Dorsum and Sole of the Foot without Injury of the Bones.)

The danger of infection in cases of wounds of the foot is evident, especially in individuals of uncleanly personal

habits. Prolonged suppurative processes and edema of the foot and leg are the consequences to be feared.

Treatment.—Rest in bed, careful cleansing of the part, and antiseptic dressings are indicated. Compresses wet with a solution of acetate of alum are very serviceable.

The effect of the scar on the functional action of the foot varies with its location. A scar at the point of origin of the extensor communis brevis interferes with extension of the toes, and, to even a greater extent, with their flexion and with the bending of the tip of the foot downward. (See Plate 40, Fig. 1.) The mobility of the toes also suffers when a scar of the metatarsal region reaches deeply into the tissues, and at the same time the circulation of the part is interfered with. Scars of the plantar surface render walking painful, and are always liable to break open.

The insurance allowance is proportionate to the loss of functional power, being especially influenced by the effect of the lesion on walking (on whether a cane is required).

Crushing of the Foot and Toes.

When crushing is not severe, the injured part is soon restored. If, however, the foot is severely crushed under heavy objects, such as a beam, an iron rail, a block of granite, the wheel of a vehicle, etc., the results are likely to be serious. Fractures of the tarsal or metatarsal bones or of the phalanges are usually produced, the fractures frequently being compound and the parts so badly mangled as to require amputation. (See Plate 39, Figs. 1 and 2.)

Even when the bones remain intact, the extravasations of blood and injuries of the tendons are calculated to render the foot useless for some time afterward.

Laceration of the Plantar Fascia.

The fascia is sometimes torn when the foot is badly crushed, or when the os calcis, for instance, is broken by

a fall on the feet. The lesion is subsequently to be recognized by a hard, nodular growth, the size of a bean or even larger, on the inner border of the foot where the fascia is made tense by flexing the foot. For a time this is very painful, both in standing and walking, and the patient may be unable to walk at all, unless supplied with a properly padded shoe. The pain, however, diminishes in the course of time.

Dislocation of the Subcalcaneoid Bursa.

I have seen one case of this lesion. Normally, the bursa lies on the under surface of the posterior portion of the os calcis.

A hod-carrier, forty-seven years of age, in carrying a load of stones on his shoulder, made a misstep, striking the left heel very forcibly against the edge of a ditch. The part became painful, and he applied compresses. When I examined the patient, on November 22, 1897, I found the under surface of the os calcis slightly thickened; as he raised the heel from the ground in walking a cracking sound was produced, which could be heard at a distance of about six feet. The bursa, which was displaced forward, was removed and the sound disappeared.

Subluxation of the Os Calcis.

Partial dorsal dislocation of the os calcis at the calcaneocuboid articulation is a lesion very frequently met with, usually as a symptom of other injuries of the foot, such as fracture of the os calcis, simple sprain of the ankle, or sprain complicated with malleolar fracture or fracture of the astragalus. The displacement can best be determined by means of the X-rays.

The astragalus is almost always secondarily displaced to a corresponding degree; the outer anterior angle of the greater process of the os calcis is more prominent on the injured foot than on the normal one, and lies higher. In addition, the os calcis is frequently slightly rotated outward on its long axis. The position of the malleoli, especially the outer one, is also affected. The symptoms of the subluxation—which, in fact, is often more evi-

denced by the astragalus than by the os calcis itself—are, as a rule, of no great moment after the subsidence of the inflammation and swelling. Some patients, however, more sensitive than others, continue to complain of considerable pain, which is most severe when they walk and stand, and for such a more extensive course of after-treatment is required. Rest, compresses, regular massage, and medicomechanical exercises are usually successful in promoting recovery. A laced shoe with side supports is advisable for some cases. If the part remains painful, in spite of regular treatment, it is best to dismiss the patient with a temporary insurance allowance of from 20 % to 30 %. As a rule, the symptoms disappear soon afterward, and the patient recovers full working capacity.

Fractures of the Os Calcis.

(145 Cases.)

For anatomic as well as practical reasons it is best to divide the fractures of the os calcis into those of the body and those of its processes. Fractures of the body frequently involve the processes also, while the latter are often broken without other injury to the bone.

Fractures of the body are almost invariably of the class of compression-fractures, the violence acting upon the bone in a vertical line, while at the same time the astragalus is driven into its cancellous tissue. The lesion is usually occasioned by alighting on the heel after a fall or a leap from a height. The os calcis may alone be affected, or the fracture may involve the adjacent bones—the astragalus and malleoli and the lower end of the tibia.

Case of compression-fracture of the os calcis. The illustration (Fig. 108) shows the left os calcis to be greatly broadened and thickened.

The patient in this case was a carpenter, forty-four years of age, who had fallen from a scaffolding seven feet high on September 21, 1894, landing on the feet. He was treated at home at first, subsequently attending my clinic from December 21, 1894, until August

24, 1895. Insurance allowance, $33\frac{1}{3}\%$, which was reduced in October, 1898, to 25%.

The accompanying sole-impressions (Fig 109, p. 482) illustrate the case of a carpenter, thirty-nine years of age, who sustained a compression-fracture of the right os calcis on December 18, 1893, as a result of a fall from a ladder. The heel subsequently became considerably broadened; talipes varus and flat-foot developed. The impressions of the soles show the thickening of the heel and the difference between the two soles, the outer border of the affected one approaching the outer boundary-line. Insurance allowance, $33\frac{1}{3}\%$.

Symptoms after consolidation: At first the foot is swollen, especially around the ankle and over the heel, the swelling extending to the leg as well. The os calcis appears broadened, particularly at its posterior extremity, and the tubercles on its under surface may be thickened. Similar thickening of the astragalus and the malleoli is to be observed, if these were involved in the fracture. The leg is shortened in proportion to the loss of height of the os calcis, the malleoli lie on a lower plane than normally, and the depressions on either

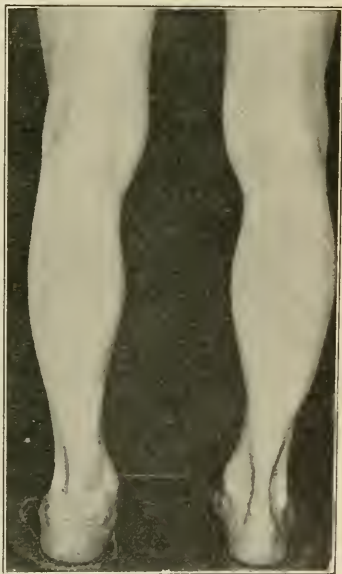


Fig. 103.

side of the tendo Achillis are filled out; the anterior portion of the foot, especially its tip, is narrowed. More or less well-defined flat-foot is a common but not an invariable symptom; talipes valgus or varus or talipes planus varus are sometimes observed, more particularly in cases complicated by fracture of the malleoli. Added symptoms are atrophy of the sole, cicatricial nodules in the plantar fascia, dis-

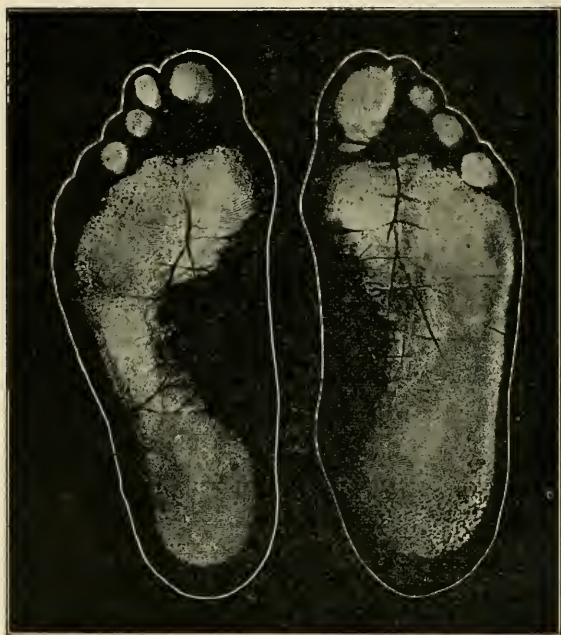


Fig. 109.



Fig. 110.

location of the tendons of the peronei opposite the external malleolus, atrophy of the muscles of the leg, especially of the calf, and, in most cases, muscular atrophy of the thigh and buttocks also. Paresthesia, such as sensations of cold, formication, venous congestion, etc., may also be in evidence. Flexion and extension of the ankle-joint are usually only slightly affected, whereas rotatory movements, or circumduction, are restricted or quite suspended. Inversion and eversion of the foot are likely to be more or less abolished, and if ossification takes place between the astragalus and os calcis, they can never be recovered. The gait is often very unnatural at first; the foot is frequently held abducted in walking.

Treatment.—From the first the patient should be warned by the surgeon against standing or walking until it is quite safe to use the injured foot. This is especially true of large, heavy individuals, in whom slow recovery and poor results are frequently attributable solely to neglect of this precaution. A shoe with side supports should be worn for a time; if the under surface of the os calcis is thickened, this should be allowed for by an appropriate pad. If, nevertheless, relief is not afforded and the patient is unable to walk, the exuberant callus should be chiseled off. Vapor baths, electricity, and massage should be employed as usual.

The patient may be sufficiently incapacitated for work to warrant an insurance allowance of from 20 % to 50 %, or even more; if there is only slight difficulty in walking and standing, 20 % should suffice.

Case of fracture of the os calcis and dislocation of the external malleolus; also partial fracture of the posterior extremity of the os calcis due to muscular action. (Fig. 110, p. 483.)

A polisher, forty-eight years of age, fell from a scaffolding about five feet high on March 13, 1896. When I examined him, on April 23, 1896, I found the left os calcis broader than normal, the malleoli somewhat thickened, and the external one displaced backward; the leg was slightly shortened, and there was a tendency to talipes valgus. Stepping on the foot caused pain in the os calcis; the foot could not be inverted and everted. The skiagraph shows the line of fracture in the



Fig. 111.

anterior portion of the os calcis very beautifully; it also shows a small portion of bone to be lacking from the upper part of the posterior extremity of the os calcis. The patient was under treatment from June 6, 1896, until January 25, 1897. Insurance allowance, at first, 50%; reduced, on May 10, 1897, to 30%.

Case of fracture of the posterior extremity of the os calcis due to muscular violence.

In the skiagraph (Fig. 111, p. 485) we can see the gap in the posterior extremity of the os calcis. The lesion occurred on January 21, 1897, when the patient, a mason, thirty-eight years of age, fell from a scaffolding about five feet high. He was treated at home with compresses and innunctions, remaining in bed for a week. The course of after-treatment lasted until August 21, 1897, when he was discharged with an insurance allowance of 25%. He was afterward able to do the regular work of a mason without difficulty. His allowance was reduced to 15% in June, 1898, and has since then been entirely discontinued. The symptoms were slight stiffness of the left ankle-joint and slight atrophy of the leg. In the summer of 1897 the gap in the os calcis was much larger than it appears in the skiagraph, reaching to about the middle of the bone, and the posterior extremity of the bone presented a distinct callosity.

The posterior extremity of the os calcis is sometimes broken off by violent contraction of the muscles of the calf in connection with a fall or blow on the heel, the lesion being primarily due to the direct violence. The bone subsequently becomes considerably thickened from above downward and the tendo Achillis passes upward over it in a curved line, with the concavity of the curve directed upward. If a skiagraph is taken, we see a triangular interval in the bone, in shape like an "open duck-bill." Pressure of the shoe on the skin over the thickened bone is likely to produce an ulcer or a callosity. Unless there are complications, the working capacity of the patient is usually but slightly affected.

In some cases of transverse fracture of the os calcis the posterior fragment is drawn upward, its sharp-edged end being so directed downward as to make walking painful or even impossible.

If the os calcis resists the violent contraction of the calf muscles, the muscles themselves may give way instead, the rupture usually occurring at the point of their insertion into the tendo Achillis. In some cases we find

the muscle ruptured and the broken extremity of the os calcis displaced upward at the same time.

The point of rupture in the calf is marked by a thickening of the muscles or by an interval between the ruptured portions. In the first instance we find a contracture of the muscles and flexion of the knee, causing a certain degree of talipes equinus; in the second the ruptured muscle becomes extremely atrophied. Shortening of the sole of the foot, or, rather, a diminution of the surface used in walking, is a characteristic symptom of upward displacement of the posterior extremity of the os calcis. This is best demonstrated by an impression of the sole made on paper coated with lamp-black.

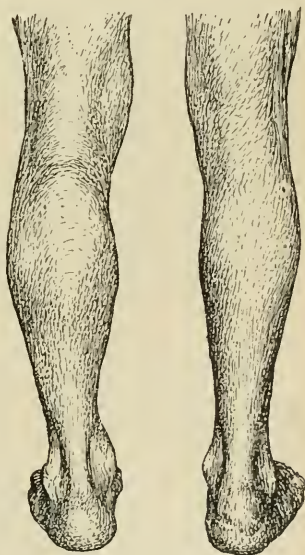


Fig. 112.

Case of fracture of the posterior extremity of the os calcis, due to muscular violence, accompanied by partial rupture of the muscles of the calf at the point of their insertion into the tendo Achillis. (Fig. 112.)

A workman, fifty-four years of age, sustained the foregoing injuries on April 27, 1895, when, in throwing himself backward on a wall from which he was in danger of falling, he struck his right heel against a slab of granite. The illustration shows the thickened extremity of the os calcis and the increased size of the tendo Achillis; also the atrophy of the calf muscles. In addition, the knee being held somewhat flexed, the patient was unable to extend it completely; flexion and extension of the ankle-joint were limited, and the sole of the foot was atrophied. He walked with a limp. The course of treatment lasted from June 4, 1895, until December 21, 1895. The ankylosis of the knee and limited power of extension were entirely cured. Insurance allowance, 33 $\frac{1}{3}$ %.

The accompanying sole-impressions (Figs. 113 and 114, p. 489) illus-

trate the case of a workman, thirty-eight years of age, who fractured the posterior extremity of the right os calcis by slipping from a board on December 10, 1895. The fracture was accompanied by marked upward displacement. The impression in figure 113 shows the limited use of the heel in walking, in consideration of which an insurance allowance of 50% was granted by the court. Walking was very difficult at first, but became quite easy later on.

On April 17, 1897, the patient again injured the same foot, on this occasion sustaining a fracture of both malleoli, as well as a fracture of the os calcis. This injury had an excellent result, as shown by figure 114, the foot regaining an almost normal position for walking. The insurance allowance was therefore reduced to 15%.

Fractures of the greater process usually occur in connection with fractures of the body. If its articular surface is involved, the calcaneocuboid joint is likely to remain ankylosed, entailing a permanent loss of the movements of inversion and eversion of the foot. In rare instances a severe sprain may cause a fracture of the greater process alone.

Fractures of the sustentaculum tali are frequently observed as an accompaniment of the so-called compression-fractures previously described. They may occur as separate lesions, although infrequently; I have myself, however, seen a number of such cases. The functional importance of this fracture is easily explained by the anatomic relations of the process. If the whole process is broken off,—which is fortunately a very rare accident,—the astragalus is deprived of its support, and slips downward and inward, causing the foot to become everted. The inferior calcaneoseaphoid ligament is partly torn, or, at any rate, becomes relaxed, and the deltoid ligament is also lacerated. In consequence of these injuries to the ligaments passing from the os calcis to the scaphoid, the latter bone lacks proper support. There is always danger of injury to the tendon of the flexor communis digitorum, which passes down on the border of the sustentaculum, and to that of the flexor longus pollicis, which runs in a groove on its under surface. If the sustentaculum is badly crushed, the tendons are likely to be overgrown by



Fig. 113.



Fig. 114.

callus, leading to contracture of the toes. In one case I found a well-marked hallux flexus.

Case of comminuted fracture of the sustentaculum tali and the internal malleolus. (Fig. 115.) Sequel, serious loss of functional power, due to contracture of the great toe.

A workman, thirty-nine years of age, was injured on August 22,



Fig. 115.

1894, by a stone falling from the height of one story, striking the internal malleolus of his right foot. He was treated at home by the lodge doctor, lying in bed for five weeks; for three months afterward he remained without medical advice. He was in my care from February 18, 1895, until July 17, 1895. There was a marked growth of callus around and below the internal malleolus, and the great toe was so much flexed as to make the end touch the ground. The patient's condition has gradually grown worse, and he is now unable to tread

on the whole sole of the foot. The other toes have become contracted as well and the foot has grown more and more deformed. The portion of the sole used in walking is shown in the accompanying impression. (Fig. 115, p. 490.) Insurance allowance, 33 $\frac{1}{3}$ %.

These contractures may very seriously interfere with the usefulness of the foot. Amputation of the offending toes is the best treatment; but if the patient objects, a laced shoe, appropriately shaped and padded, affords a certain amount of relief.

The fracture leaves the sustentaculum thickened, as is evidenced by a prominence below the internal malleolus. The posterior process of the astragalus is usually fractured at the same time, and, if so, it is also thickened. The foot and whole extremity appear atrophied; rotatory movements, including inversion and eversion, are abolished, and flexion and extension at the ankle-joint are restricted.

Bony union between the os calcis and astragalus takes place regularly after fracture of the sustentaculum, as well as after compression-fractures of the os calcis; and, in addition, the ligaments connecting the bones—the interosseous ligament in the interosseous groove, for instance—may undergo ossification.

The insurance allowance in severe cases amounts to from 30% to 50%, or more; in light cases, from 15% to 20%.

Fracture of the internal tubercle on the inferior surface of the os calcis is a very interesting lesion, both from an etiologic and a functional standpoint. The tubercle is pulled forward by the strong plantar muscles and the tense ligaments which are attached to it, appearing at the middle of the under surface of the bone as a rounded, thick, bony prominence, making walking very painful and difficult.

As early as 1895 I called attention to these fractures at the Convention of Scientists at Lübeck. Thiem at that time denied their occurrence. Affirmative proofs were subsequently furnished by Ehret in an article published in the "*Archiv für Unfallheilkunde*," volume 1. One such case has occurred in my practice.

Case of fracture of the internal tubercle of the os calcis, consequent upon a fall, leading to slight functional disability.

The thickened tubercle is shown in the accompanying illustration. The condition is most noticeable with the feet placed parallel, as in figure 116. The tubercle was carried forward by the plantar muscles after its separation. Insurance allowance since August, 1898, 20%.

It is unnecessary to speak further of the symptoms of the lesion, as they are essentially similar to those referred to in connection with the transverse fractures of the bone and the subsequent thickening of its lower surface.

Separation of the tubercle on the external surface of the os calcis may accompany fracture of the body, or, in very rare cases, may occur alone as a result of direct violence. The development of the tubercle is very much an individual matter; it is entirely lacking in some cases, while in others it forms a marked prominence. Sometimes there are two tubercles, and Hyrtl has even observed three. The tubercle most constantly present is the larger one, lying below the external malleolus; the tendon of the peroneus longus passes down behind it, and it is conceivable that it might pull off the tubercle, if the latter were of large size and the foot were very forcibly supinated. It is, however, out of the question for the tubercle into which the calcaneofibular division of the external lateral ligament is inserted to be separated by traction on the part of the latter. I have never seen a case of indirect fracture of this tubercle myself, although I have known it to be broken off by direct violence—in one case by a blow from a falling stone, and in another, by falling

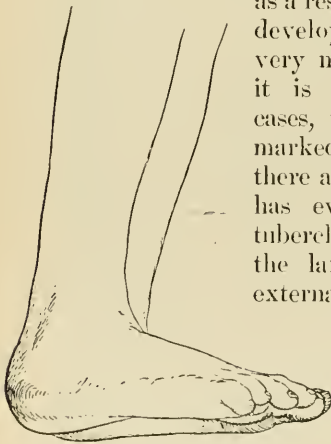


Fig. 116.



Fig. 117.

and striking the outer side of the foot on a sharp-edged stone. In a case in which the tendons of the peronei had become involved in the callus there was spasm of the antagonistic muscles of the leg, causing a talipes varus and making the foot almost useless.

The outcome is more favorable when the peronei form for themselves a groove in the callus in which they can glide.

A very unusual accident is cited below, with an illustration (Fig. 118), in which the os calcis was fractured by a stroke of lightning.

Case of spontaneous fracture of the os calcis (compression-fracture). Predisposing cause, tuberculosis of the os calcis; exciting cause, unknown. (Fig. 117, p. 493.)

A workman, thirty-nine years of age, while carrying a load of stones, suddenly felt a pain in the right foot. He also noticed that the foot appeared swollen. He began medical treatment and applied for insurance allowance. I took a skiagraph of the foot on July 7, 1897. A diagnosis was thereupon made of tuberculosis. The patient was small, delicate, and poorly nourished. The lungs were normal. At the time of my examination the foot was reddened and greatly swollen; subsequently the swelling diminished somewhat. Insurance allowance was refused, as there was no proof of the occurrence of an accident.

Figure 118, page 495, shows the very unusual case of a fracture of the os calcis caused by a stroke of lightning. The patient, when eighteen years of age, was struck when standing at a window; the bolt entered the right side of the chest, throwing him to the floor, and is said to have passed out at the right heel (the scar on the right side of the chest is still visible). The skiagraph shows the peculiar jagged deformity of the bone. The patient suffered from suppuration of the bone for nearly a year and a half, during which time splinters were continually being thrown off. He gradually regained strength, and was able later on to do the full work of a hod-carrier.

Dislocation of the Scaphoid.

(My Cases Include Eighteen of Dislocation-fracture or Subluxation of the Scaphoid.)

Occurring separately, this is a rare form of injury.

Dislocation-fractures are met with less infrequently. Subluxations are seen comparatively often, the bone being, as a rule, displaced downward or inward.



Fig. 118.

The lesion may be caused by a misstep when carrying a heavy load, by an awkward jump, by turning the ankle inward, or it may occur in consequence of a heavy object falling on the foot, or some similar accident. An examination by the X-rays will show the displacement at the astragaloscaphoid joint very clearly. Apart from this, the symptoms consist of eversion of the foot, of swelling extending from the internal malleolus to beyond the first cuneiform bone, and of marked projection of the tubercle of the scaphoid. The inner arch of the foot lies nearer the ground than on the normal foot, and the outer border may be so much raised that it does not touch the ground in walking. The foot is painful and the muscles are atrophied.

The pain may be severe and very persistent; it can be somewhat relieved by means of a laced shoe padded as for flat-foot, which aids also in overcoming the deformity.

Insurance allowance, from 25 % to $33\frac{1}{3}$ %.

Fracture of the Scaphoid.

The lesion occurs as the result of direct violence, as when the foot is crushed by a heavy weight, or of indirect violence, as in wrenching the foot loose when it is caught fast. In the latter case the fracture is not infrequently comminuted, and accompanied by more or less displacement of the bone upward or inward.

The injury is subsequently manifested externally by swelling of the foot, extending from the ankle-joint to the anterior portion of the first metatarsal bone. As a rule, the head of the astragalus and the three cuneiform bones are more or less involved in the injury. Patients complain of pain on standing and of an inability to carry heavy loads. The foot can not be inverted or everted. In cases of fracture due to direct violence the adjacent bones are usually involved as well; the arch of the foot sinks down and flat-foot is frequently developed. The



Fig. 119.

thickened bones can in many cases be felt through the sole.

Figure 119, page 497, and figure 120, page 499, illustrate the case of a hod-carrier, thirty-one years of age. On March 18, 1895, when mounting a ladder with a load of bricks, his wooden shoe fell from his right foot. In order not to endanger the man behind him, he was obliged to mount the remaining five rungs of the ladder with his foot unprotected. Each step caused intense pain in the foot, which became greatly swollen, causing him to discontinue work. He was treated at home with bandages and ointments until April 20th. Then he entered a hospital, where, however, he remained only for six days. While there he was treated with massage. I first examined him on June 4, 1895, and had him under treatment until October 7, 1895. The foot was greatly swollen, especially just in front of the malleoli. There was a bony protrusion in front of and partly underneath the internal malleolus, a similar condition, only more marked, existing in front of the external malleolus. A rather hard mass could also be felt at the inner border of the inner arch of the foot. When discharged, the patient was granted 35% insurance allowance. He returned for further treatment on February 26, 1896, on account of an increase of the symptoms, being discharged for a second time on November 23, 1896. Diagnosis was made of fractures of the greater process of the os calcis, the neck of the astragalus, the scaphoid, and the tubercle on the posterior surface of the astragalus. The skiagraph (Fig. 119, p. 497) shows the fracture of the scaphoid and the partial splintering of the cuneiform bone very distinctly. The line of fracture on the neck of the astragalus can also be traced; that of the upper border of the greater process of the os calcis is less distinctly visible. The posterior tubercle of the astragalus is seen to be displaced in the direction of the os calcis. The displacement of the fractured scaphoid is plainly shown in figure 120. The patient is now able to walk fairly well, and the symptoms have considerably diminished.

Direct fractures of the three cuneiform bones are caused in the same manner as fractures of the scaphoid, and as the symptoms are also identical, it will be unnecessary to repeat them.

Case of subluxation of the first cuneiform bone. (Fig. 121, p. 500.)

A hod-carrier, thirty-six years of age, fell from a ladder on May 1, 1896, striking on the left foot. He was already a sufferer from flat-foot. He was treated in the hospital, wearing a plaster cast for twenty-four days. The course of after-treatment lasted until January 25, 1897, when he was discharged with an insurance allowance of 25%. The illustration distinctly shows a convex tumor on the dorsum of the foot and a similar but less well-marked protrusion on the plantar surface. The former represents the upward displacement of the base of



Fig. 120.

the first metatarsal bone; the latter, the downward displacement of the first cuneiform bone.

Case of subluxation of the scaphoid (downward displacement). (Fig. 122, p. 501.)

A workman, thirty-five years of age, was injured on April 23, 1887, by a falling beam, which crushed his right foot. He was at first treated at home; later on, in my clinic. It was difficult for him at first to bear his weight on the injured foot. He improved greatly under treatment, however, and was discharged on December 20, 1887, with an insurance allowance of 25%, which was reduced to 10% in July, 1889. In the beginning of 1890 he fractured the left ankle, after which the right foot became more painful. Full capacity for self-support was recovered by 1897. The skiagraph shows the downward displacement of the scaphoid, partly involving the first cuneiform bone as well, and the upward displacement of the first cuneiform and first metatarsal bones at the point of their articulation.

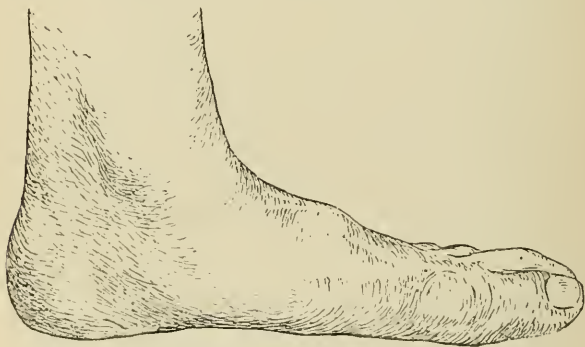


Fig. 121.

The cuneiform bones are very seldom completely fractured by indirect violence; overflexion, however, when the foot is caught fast, sometimes causes small splinters to be chipped off. The after-symptoms are similar to those of fracture of the bases of the first three metatarsal bones.

Indirect fractures of the bones of the inner arch, involving both the scaphoid and the cuneiform bones, occasionally occur as the result of carrying extraordinarily heavy loads.



Fig. 122.

The chief aim of after-treatment of all the fractures of the inner arch is to furnish the patient with the best possible support in standing and walking. A properly shaped and padded shoe is of prime importance, although massage, local baths, and gymnastic exercises will also be found beneficial.

Dislocation of the Cuneiform Bones.

(My Material Includes Forty-two Cases of Dislocations, Fractures, and Dislocation-fractures of These Bones.)

The first cuneiform bone is the one most subject to dislocation. Either of the others may, however, suffer separately, or all three may be dislocated at once. The majority of cases occur in connection with fracture, the fragments being then displaced upward or downward, or, in the case of the first cuneiform bone, possibly inward.

Subluxation occurs more frequently than complete dislocation ; splinters are apt to be chipped off the adjacent bones at the same time.

The lesion is caused by direct violence when heavy objects fall on the foot, displacing the bone downward. Indirectly, it occurs when a person catches the toes in an opening and falls over backward, thus forcibly bending the foot.

Subluxation, too, is most often met with in the first cuneiform bone. In cases of downward displacement our attention is first attracted to the lesion by the prominence of the scaphoid or the base of the first metatarsal bone on the back of the foot ; the first cuneiform can be felt to project on the plantar surface, and is usually sensitive to pressure. The inner border of the foot remains swollen for some time, and if the foot is only slightly arched, the patient avoids stepping on it, and walks on the outer part of the sole. If the arch is a high one, there is no abnormality of gait, but standing for any length of time or carrying heavy weights becomes painful.

The toes remain stiff for a time, especially the great toe, and the plantar muscles are temporarily atrophied.

Considerable relief is afforded the patient by a suitable shoe.

Insurance allowance, from 15 % to 25 %, or more.

In cases of upward displacement the symptoms are similar, except that the dorsum of the foot appears abnormally prominent and no projection is felt on the sole.

Dislocation of the Cuboid.

(The Cuboid Was Injured in Twenty-two of My Cases.)

Complete dislocation of the cuboid is a very unusual lesion.

Subluxation occurs more often ; it is observed when the back of the foot is crushed, especially when it is compressed between two objects, and violent efforts are made to extricate it. When the bone is displaced upward, it appears as a distinct prominence on the outer border of the foot. The belly of the extensor communis brevis stands out more distinctly than on the uninjured foot, and the outer toes are somewhat extended by the tension of their respective tendons. There may be talipes varus, the patient walking on the outer border of the foot, but in some cases we find talipes valgus. Downward displacement leaves a depression on the outer side of the back of the foot, and the foot is held everted.

Patients usually complain of pain on the outer part of the back of the foot, and along its outer border, running across the sole to the point of insertion of the peroneus longus. A laced shoe, appropriately padded, will somewhat relieve the pain and discomfort experienced on standing and walking, which are also favorably affected by massage and medicomechanical exercises systematically carried out. Operative interference is sometimes indicated. The rule for all except the most severe cases is that the symptoms entirely disappear by the end of six months.

Insurance allowance, from 20 % to 33 $\frac{1}{3}$ %.

The dislocation-fractures of the cuboid are usually multiple or comminuted, occurring when the foot is badly crushed. The fragments are likely to be displaced quite irregularly.

Fractures of the Cuboid.

Direct violence to the foot in cases of caving-in accidents or when the foot is struck by heavy falling objects, or occurring in the form of a fall or leap from a height, is the usual cause of these fractures. They generally involve the adjacent bones; the tubercle on the base of the fifth metatarsal bone is most likely to suffer; the greater process of the os calcis, however, and the bases of the fourth and fifth metatarsals are usually fractured also.

The subsequent thickening of the bone is most perceptible through the sole of the foot, which is held everted in walking, partly because of the pain caused by pressure, partly because of the prominence of the bone on the outer border. The strain put on the tendon of the peroneus longus by the maintenance of this position is likely to cause an irritation or inflammation of the latter. In some cases, however, this is to be attributed to direct injury from pressure of the callus. *Genu valgum* is frequently observed.

The patient should wear a shoe so made as to relieve the cuboid from pressure.

Dislocation and Subluxation of the Metatarsal Bones.

Partial dislocation of the metatarsal bones at their basal extremities occurs under the same conditions as do similar lesions of the cuboid, and gives rise to almost identical symptoms. The displacement may be upward or downward. Upward displacement of the bases of all five metatarsal bones produces *talipes cavus*, shortening the foot. Displacement downward brings about the opposite condition of flat-foot. If the head of one or more of the metatarsal bones is dislocated downward, its base may be

proportionately displaced upward. In such a case the patient always complains of pain on bearing his weight on the foot, and tries to avoid stepping on the painful part. If the fourth metatarsals are involved, therefore, the foot will be held everted in walking. The position of the heads is indicated by a rounded eminence on the sole of the foot, and the affected toes are usually fixed in more or less pronounced extension. The gait is affected in proportion to the deformity. A laced shoe, padded to allow for the projection of the dislocated bones on the tread, is a very necessary requirement.

The average insurance allowance is 20 %.

The symptoms which develop when the heads of the metatarsal bones are displaced upward have an even more unfavorable influence on the ability of the patient to walk or stand. The affected toes are usually flexed.

Lateral dislocation of individual metatarsal bones is possible only in the case of the first and fifth, and occurs, doubtless, in all cases in connection with fracture of their bases. Unless the dislocation or subluxation is completely reduced, the foot becomes abnormally broad, or flat-foot may develop. In case of inward dislocation of the first metatarsal bone the foot is narrowed in the middle of its transverse arch. The joint between the first metatarsal and the first cuneiform becomes enlarged, and perhaps inflamed.

We occasionally meet with lateral dislocation of the metatarsal bones as a whole at the tarsometatarsal joints in connection with fracture of the latter. The metatarsal bones usually remain displaced either outward or inward, and flat-foot or club-foot is likely to develop. Walking is very difficult for a time, and a well fitting and properly padded laced shoe is an important factor in restoring the usefulness of the foot.

Insurance allowance, from 25 % to 33½ %.

PLATE 39.

FIG. 1.—A workman, thirty-eight years of age, sustained a compound fracture of the bones of all five toes of the right foot on November 1, 1897, caused by three beams falling upon the back of the foot. The first two toes had to be amputated. The contracture of the remaining three toes and the extensive scars on the back of the foot are shown in the illustration. The skin appears cyanotic. The skiagraph (Fig. 124, p. 508) shows the fractures of the metatarsal bones and the position in which the heads of these bones became consolidated. The extreme degree to which the foot was shortened is shown in the sole-impressions of figure 123, page 507. Insurance allowance, $33\frac{1}{3}\%$.

FIG. 2.—This illustrates the case of a workman, twenty-eight years of age, the great toe of whose left foot was fractured on November 18, 1897, by the fall of an iron bolt. The fracture was compound. The line of fracture is visible in the accompanying skiagraph. (Fig. 125, p. 509.) The scar over the metatarsophalangeal joint of the great toe, the glossy skin of the part, and the retraction of the scar, throwing the skin into radiating folds, are shown in figure 2. It was at first very difficult for the patient to place the inner border of the foot to the ground, on account of the protrusion of the ball of the great toe. The appearance of the foot at the time of the patient's discharge, on August 6, 1898, was identical with this illustration, but the gait was excellent. Insurance allowance, $33\frac{1}{3}\%$, at first, advanced by the court to 50%; in February, 1899, it was reduced to 20%.

Fractures of the Metatarsal Bones.

(112 Cases.)

These fractures are of frequent occurrence in the building and allied trades, in which the foot is exposed to injury from falling objects. They are usually of the direct variety, and often pass unrecognized under the diagnosis of "crushed foot." Indirect fractures are caused by turning the ankle, especially when a workman, in carrying a heavy load, catches the foot in something, in which case the fourth and fifth metatarsals are most likely to be the seat of fracture. The second and third are less frequently involved. Sometimes the fracture occurs as the result of putting the foot down very heavily to mark time in marching.

Direct fractures of the first three metatarsal bones lead to the development of flat-foot. This is the necessary



consequence of the lesion, caused, as it is, by the impact of a heavy object on the posterior extremity of the bones, since these do not rest on the ground, but rely for their support on the various ligaments which maintain the shape of the arch.

Fractures of the first metatarsal bone are likely to lead to deformities which seriously interfere with the usefulness



Fig. 123.

of the foot. This is especially the case when one or both fragments are displaced downward. Consolidation is accompanied by a well-marked growth of callus, which adds to the deformity—the more so the nearer the fracture lies to the so-called ball of the great toe. The sesamoid bones at the anterior extremity of the first metatarsal bone



Fig. 124.



Fig. 125.

are frequently broken or dislocated at the same time by direct violence, making walking doubly painful for a long period. In examining the injured foot we find the part of the sole corresponding to the anterior portion of the first metatarsal bone much more prominent than on the normal foot. (See Plate 39, Fig. 2.) The prominent portion is hard and is sensitive to pressure. The effort of the patient to avoid pain causes him to walk on the outer part of the foot, which, if not treated in season, may lead to a paralysis of habit.

In other cases the fragments are displaced inward, greatly increasing the anterior transverse diameter of the foot. Hallux valgus or varus occurs as a secondary result of the displacement of the anterior fragment.

The upward displacement of one of the fragments shortens the foot, and is of practical importance, since it obliges the patient to wear a special shoe in order to protect the callus on the back of the foot from pressure.

Case of compound fracture of the first metatarsal bone, with consequent slight spreading of the toes. (Fig. 126, p. 511.)

The skiagraph shows the condition as it existed shortly before the patient's discharge from my hospital. He was nineteen years of age; his left foot was injured on March 12, 1897, by a signboard falling upon it. Suppuration set in in the metatarsophalangeal joint of the great toe, which was opened and drained in the hospital. He was discharged from after-treatment on October 16, 1897, with an insurance allowance of 25%. He walked on the outer edge of the foot, being prevented from treading on the ball by the scar on the under surface of the great toe.

The skiagraph (Fig. 127, p. 512) illustrates a case of fracture of the posterior extremity of the first metatarsal bone, of the base of the second metatarsal, and of a partial transverse fracture of the anterior portion of the third metatarsal bone. The back of the left foot was crushed at the same time by the iron beam which caused the injury, and the patient, a man forty-four years of age, was sent to me with a diagnosis of crushed foot. He was under treatment from October 1, 1894, the date of the injury, until May 9, 1899.

When discharged, he received an insurance allowance of 30%, reduced in May, 1899, to 10%. In addition to the flat-footedness which was consequent upon the injury, the first and second metatarsal bones were thickened and the anterior portion of the third metatarsal bone was also slightly thickened. This condition caused difficulty in walking at first; subsequently, the thickening became much less marked, and the gait improved in proportion.



Fig. 126.



Fig. 127.



Fig. 128.

Case of reunited fracture of the heads of the first and fifth metatarsal bones accompanied by subluxation of the second, third, and fourth metatarsal bones upward, and by inward displacement of the fifth. (Fig. 128, p. 513.) The accident causing these injuries was a caving-in.

The patient was at first treated in a hospital, entering my hospital for a course of after-treatment on September 9, 1897. At first he walked with difficulty, using a crutch and a cane. He was discharged on November 27, 1897, with an insurance allowance of $33\frac{1}{3}\%$. The foot presented a talipes varus, and the dorsum was distinctly convex. Flat-foot had previously existed. The skiagraph shows the fractures and the displacement of the metatarsal bones very distinctly.

Case of fracture of the head of the fifth metatarsal bone, with upward displacement of the little toe and the bases of the second, third, and fourth metatarsal bones. (Fig. 129, p. 515.)

The patient in this case was a workman, fifty-one years of age. On March 8, 1898, a building-stone fell on the little toe of the left foot, causing the ankle to turn outward. He was under treatment until November 19, 1898. The displacement of the several bones is clearly shown in the skiagraph. Insurance allowance at the time of discharge, 20%.

Case of fracture of the second and third metatarsal bones with displacement of the metatarsal bones and the first and second cuneiform bones. (Fig. 130, p. 516.)

In this case the injury was caused by a signboard falling on the right foot. The patient, who was a painter, twenty-eight years of age, was under treatment for five weeks; in the sixth week he began to work again, and at the end of a few weeks more had completely recovered.

The displacement of the bones is well shown in the skiagraph.

Case of fracture of the third, fourth, and fifth metatarsal bones. (Fig. 131, p. 517.)

A workman, twenty-six years of age, was hit on the left foot with a club on September 7, 1897. He was treated at home for fourteen weeks, at first with ice-compresses and by rest in bed; later on, by massage. He then entered upon a course of treatment in my clinic, which was continued until April 25, 1898. The skiagraph was taken at the time of his discharge. The back of his foot presented a convex deformity and the foot was slightly broadened across the middle. At first he was very lame; his gait afterward became perfectly normal. Insurance allowance, 25%.

If the fracture involves the anterior portion of the metatarsal bones, the heads of the respective bones may become entirely displaced downward, to the side, or, far less frequently, upward. Downward displacement interferes directly with treading on the foot; lateral dislocation has a similar unfavorable effect, although indirectly, by



Fig. 129.



Fig. 130.



Fig. 131.

causing pressure on the heads of the adjacent bones. Prominent points corresponding to the displaced fragments can be seen on the back of the foot, and are even more distinctly perceptible on palpation.

In some cases we find these fractures to be incomplete ; the bones are bent or broken only part way across. They permit, nevertheless, of sufficient lateral displacement of the heads of the injured bones to cause pressure, which gives rise to pain in walking.

The joints are affected in proportion to their proximity to the fracture. The pain in walking, of which the patients complain, may be due to ankylosis or to the displacement alone. The displacement at the tarsometatarsal joints is definitely limited ; the joints remain painful, however, for walking and standing for a considerable length of time.

The position of the toes is necessarily altered by displacement of the anterior fragments. In some cases we find them extended ; in others, they are displaced backward, together with the anterior fragments ; or, again, they are held more or less tightly flexed. If the line of fracture runs through the heads of the metatarsal bones into the metatarsophalangeal joints, ankylosis of the latter is an invariable sequel. After fracture of the fifth metatarsal bone, accompanied by lateral dislocation, the foot becomes broadened, as in cases of fracture of the first metatarsal bone.

I have seen two cases in which separation of the tubercle at the base of the fifth metatarsal bone formed the sole lesion. One patient was a workman, about forty-five years old, who had caught his foot in a roof-gutter, and had fallen down on the roof. He did not stop work. The other case occurred in a tall, heavily built hod-carrier, who had fallen from a ladder. He remained in bed for six weeks, as walking was painful, but resumed work soon afterward.



Fig. 132.

Traumatic Flat-foot.

Notwithstanding the fact that the traumatic development of flat-foot does not accord with the ordinary theory of origin of the deformity, it seems proper to use this term when the arch of the foot, in consequence of traumatism, becomes so much lowered as to allow it to touch the ground in walking.

This condition is met with after fractures involving the bones of the inner arch (os calcis, scaphoid, cuneiform bones, and first to third metatarsal bones). Traumatic flat-foot gives rise to the same painful symptoms as the nontraumatic variety.

The treatment, besides wearing an appropriate shoe, includes massage, baths, etc.

The rate of insurance allowance is estimated according to the functional disability; as a rule, it amounts to from 25 % to 33 $\frac{1}{3}$ % or more.

Flat-foot (*talipes planus*) is to be distinguished from *talipes valgus*, which is a different deformity, although it may represent a preliminary stage of the former. The term is sometimes loosely applied in describing a condition which in reality is a valgus.

In old cases of flat-foot, giving no trouble whatever, a sprained ankle or severe contusion may cause the development of all the acute symptoms of a recent case of traumatic origin, requiring the same careful treatment and entitling the patient to the same insurance allowance. Such a case is covered by the clause relative to the exacerbation of a chronic disorder in consequence of an accident.

The sole-impressions shown in figure 135, page 522, illustrate the case of a mason, sixty-four years of age, who fell from a scaffolding on September 18, 1893, sustaining a typical inversion-fracture of the ankle-joint. As *talipes varus* existed to an extreme degree, and the ankle was completely stiff, an operation was performed in the hospital for the substitution of a *talipes valgus*. The foot remained in plaster for eighteen weeks. At the time at which I examined the patient only



Fig. 133.



Fig. 134.

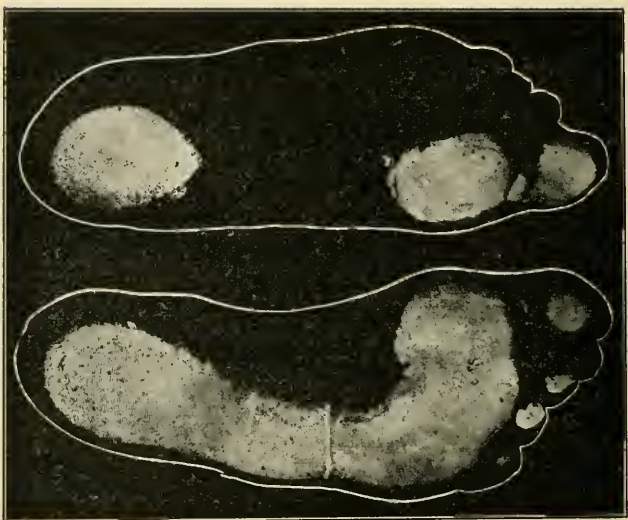


Fig. 135.

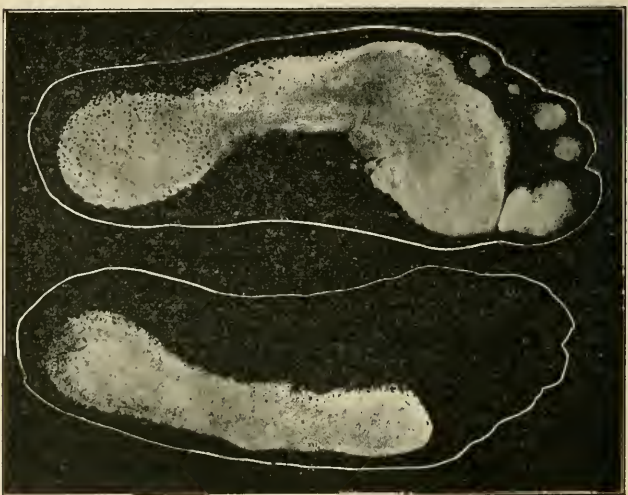


Fig. 136.

the inner border of the foot was used in walking, as is shown in the accompanying impression. (Fig. 137.) The patient is still obliged to use a cane; the ankle and leg remain greatly swollen and the ankle is completely ankylosed. He receives 100% insurance allowance, partly in consideration of his advanced years.

The sole-impressions shown in figure 136, page 522, are taken from the case of a carpenter, thirty-four years of age, who leaped from a wall one story high on November 5, 1897, spraining the right ankle.



Fig. 137.

This lesion was accompanied by a dislocation of the inferior tibio-fibular articulation and a fracture of the external malleolus.

When I examined the patient, on December 16, 1897, I found a marked case of talipes varus; the toes did not touch the ground. The portion of the sole used in walking is shown in the accompanying impression. (Fig. 136.) There was a slight genu valgum, and the muscles of the foot and leg appeared atrophied. The patient was under treatment until July 29, 1898, when he was discharged with 50% insurance allowance. His gait had somewhat improved.

PLATE 40.

FIG. 1.—A potter, forty-three years of age, on September 9, 1897, fell, with the ladder on which he was standing, a piece of iron falling on his foot at the same time. The contused wound over the point of origin of the extensor communis brevis became the seat of an adherent scar, which interfered with flexion of the toes for a considerable length of time. Insurance allowance, 30%, partly on account of the atrophy of the foot; this was reduced in June, 1899, to 15%. The patient was under treatment for a full half year.

FIG. 2.—A painter, thirty-nine years of age, fell from a scaffolding on September 10, 1897, sustaining a compound dislocation-fracture of the astragalus. He was treated in the hospital, where a plaster cast was applied. A club-foot resulted, and the leg was lengthened by the malposition of the tibia on the astragalus, the margins of the lower articular surface of the former resting across the margins of the trochlea of the latter. The ankle-joint was entirely stiffened and the leg was greatly atrophied. The illustration shows a convex prominence between the leg and the back of the foot and the scar on the outer side of the ankle. In the skiagraph (Fig. 132) is seen the displacement at the ankle-joint and the projection of the head of the astragalus. The comparison between the sole-impressions taken at the commencement and at the end of the medicomechanical course of treatment is very interesting. When the patient entered my hospital, on March 28, 1898, he was unable to stand with the feet placed parallel, but was obliged to put the right foot in front of the left. Very little of the foot was used in walking, as is shown in figure 133, page 521, in which the extreme degree of talipes varus that existed can also be recognized. When discharged, on August 6, 1898, the varus had been overcome to a considerable degree, the feet could be placed parallel, and the gait was strikingly improved. (Fig. 134, p. 521.)

Insurance allowance, 75%.

The skiagraph taken at the time of his discharge showed the external malleolus to be entirely displaced from the tibia at the inferior tibiofibular joint; the anterior extremity of the os calcis was displaced upward at the calcaneocuboid joint; the head of the astragalus was also displaced upward, and the tibia was slightly rotated on the trochlea of the astragalus. The insurance allowance was reduced in March, 1899, to 30%.

The sole-impressions shown in figure 137, page 523, illustrate the case of a mason, thirty-three years of age, who stepped on a small stone and sprained his ankle on December 12, 1896. In addition to the sprain, there was a dislocation of the external malleolus and a slight splintering of the greater process of the os calcis.

When I examined the patient later on, there was marked talipes varus; the patient walked entirely on the outer edge of his foot, which, in addition, presented internally a concave, and externally a



Fig 1.



Fig 2

convex, deformity. The skiagraph shows a typical displacement of the ankle-joint, mid-tarsal joint, and inferior tibiofibular joint. The part remained extremely painful for a long time, and the atrophy of the whole extremity was very persistent. The patient was discharged on September 24, 1897, with an insurance allowance of 50%, reduced in April, 1898, to 20%, the condition of the foot having gradually improved. There has been no change as to rate since that time.

Traumatic Club-foot.

This develops as a sequel of fracture or dislocation of the astragalus (outward dislocation), fracture of the os calcis and astragalus both, or fracture of the metatarsus. The most striking deformities are seen after fractures of the os calcis and astragalus or after dislocation-fractures of the latter. (See Plate 40, Fig. 2.)

True club-foot must be distinguished from talipes varus, which may exist without constituting a club-foot.

Functional disability is usually extreme in cases of traumatic club-foot, and a long course of treatment is required. Insurance allowance, from 33 $\frac{1}{3}$ % to 50%.

The subject of the accompanying illustration (Fig. 138) was a workman, forty years of age, who sustained a comminuted fracture of the internal malleolus and the sustentaculum tali. The great toe gradually became flexed and contracted to such a degree that at the present time the nail touches the ground when the patient is standing. The muscles of the foot are greatly atrophied. Insurance allowance, 33 $\frac{1}{3}$ %, at first; at present it is 50%.

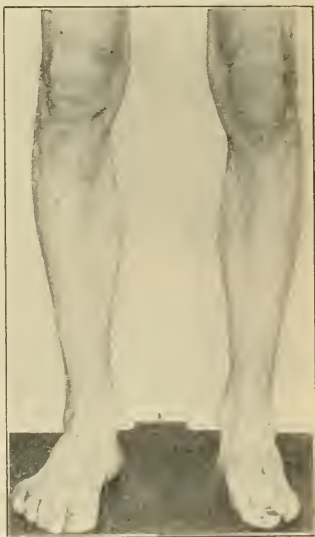


Fig. 138.

Case of traumatic talipes varus and flat-foot caused by fracture of the second toe, which was subsequently removed, together with a portion of the corresponding metatarsal bone.

The patient was a carpenter, fifty years of age, who was injured in August, 1894, by a piece of wood falling on the tip of his left foot. The talipes varus is marked; the third and fourth toes override the first; the extensor tendons appear very tense, especially that of the tibialis anticus, and the muscles of the leg are atrophied. Insurance allowance, 33 $\frac{1}{3}$ %. The condition of the patient is rather worse, if anything, than formerly.

Case of left talipes varus, following a fracture of the left leg, with displacement and shortening. (Fig. 139, p. 527.)

A mason, twenty-seven years of age, fell from a ladder on December 10, 1892, fracturing his left leg in its lower third. The bones healed with lateral displacement, the convexity being directed outward, the concavity inward; there was an extensive growth of callus and the leg was distinctly shortened. The patient was treated in the hospital for nine weeks, receiving subsequently an insurance allowance of 40%, reduced in December, 1893, to 20%. There has been no important change in his condition since that time. The sole-impressions (Fig. 139) show the difference between the two feet very well; the left imprint is smaller than the right and the foot presents a curvature which is convex externally, concave internally.

The sole-impressions of figure 140, page 527, show a slight talipes varus and atrophy of the foot, with consequent decrease of size of the tread, following a fracture of the right thigh.

The bones were much displaced at the point of fracture, causing a well-marked genu varum.

The patient was a workman, thirty-five years of age, who was crushed by a wagon against an iron column. He was treated at home by splints and extension, and received a course of after-treatment in my hospital from October 24, 1898, until January 28, 1899. Insurance allowance, 30%.

Dislocations of the Toes.

Unless reduced, the usefulness of the foot may be considerably affected by these dislocations. Dorsal dislocation is the most frequent form, and is most often seen in the case of the great toe. Permanent upward displacement of any of the toes is always a serious matter. The patient is forced to pay great attention to his shoe, to see that it is properly shaped and well made; yet, even with this precaution, injury of the skin over the projecting toes can not well be avoided, and abrasions frequently occur, requiring surgical treatment. The toes being more or less stiff, the mid-tarsal joint and ankle-joint become secondarily affected; muscular atrophy, beginning in the foot, proceeds upward along the leg and thigh until even the buttocks become wasted on the affected side. Patients complain of the foot feeling cold, especially in winter. These symptoms are in many cases gradually overcome to a certain extent, but they never completely disappear. Permanent dislocation of the toes downward interferes



Fig. 139.

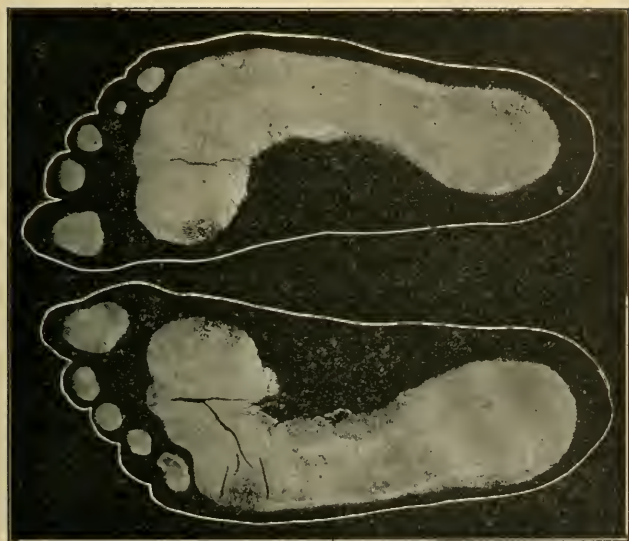


Fig. 140.

greatly with walking and standing. This form of dislocation is most often seen in the fourth and fifth toes.

The accompanying sole-impressions (Fig. 141) illustrate the case of a workman, thirty-five years of age, who sustained a compound comminuted fracture of the toes and metatarsal bones of the right foot,



Fig. 141.

which was crushed under a heavy beam. A marked case of club-foot was the result. The great toe is displaced upward to a considerable extent, and is quite stiff; the second and third toes had to be removed; the fourth and fifth are tightly flexed and touch the ground in walking. Insurance allowance, 100%.

Disarticulation leaves the foot much more useful than it can possibly be when the toes are permanently dislocated, and patients should be strongly advised to submit to this operation or to amputation of the toes.

In cases of permanent partial or complete dislocation of the toes upward the working capacity is diminished by $33\frac{1}{3}\%$ to 50% , or over, and an equally high rate may be warranted in cases of dislocation downward.

Fractures of the Toes.

(117 Cases.)

These fractures, which occur when the foot is crushed, are likely to be compound and to extend to adjacent parts of the metatarsal bones. They are produced by the impact of heavy objects, such as stones, slabs of granite, beams, iron rails, etc. The severity of the injury depends both on the surface on which the foot rests at the time of accident and on the weight of the object by which it is crushed. We frequently have to deal with badly comminuted fractures requiring the amputation of a portion or of the whole of the foot. The very effort of the surgeon to preserve as much of the foot as possible sometimes, far from giving the patient a relatively serviceable member, results in a deformity which greatly adds to his functional disability. (See Plate 39, Fig. 1.)

The great toe is the one which most often suffers alone. The fractures of the metatarsophalangeal joint, having already been discussed in connection with the metatarsal bones, can be passed over here. Nor does the ankylosis which follows these fractures need any explanation. After a compound fracture at this joint the circulation of the great toe is likely to be impeded by the scar encircling the injured joint. The toe therefore appears cyanotic for a long time after recovery (see Plate 39, Fig. 2); the temperature of the part is lowered, or, occasionally, is somewhat raised. The toe is exceedingly sensitive to

cold, a matter of considerable importance to workmen employed out of doors during the winter. An insurance allowance is justified on this point alone ; it is also based, however, on the stiffness of the metatarsophalangeal joint, which in many cases obliges the patient to walk on the outer border of the foot. In view of these facts it would be unreasonable to agree to the position taken by some that a stiff great toe does not warrant an insurance allowance.

Ankylosis of the distal phalangeal joint has a less unfavorable effect, but even this is to a large extent an individual matter. Compound or comminuted fractures of this joint often require a comparatively long course of treatment, and pain and disturbances of gait may be marked symptoms.

Fractures accompanied by crushing of the distal phalanx lead almost invariably to the destruction of the nail-bed ; a suppurative onychia frequently follows the injury, the nail is thrown off, and the whole distal phalanx becomes wasted and deformed. I have sometimes observed a subsequent rudimentary growth of the nail, but have never known it to cover the whole nail-bed. It is likely to grow very thick at the posterior border of the matrix, constantly requiring careful trimming to avoid pressure from the shoe ; but although processes of apparently healthy nail frequently grow out forward, they always fall off again, leaving the whole front part of the nail-bed covered by a soft corneous layer, which completely merges into the skin in front and at the sides. In one such case, which I have had under observation for ten years, the condition of his toe still causes the patient considerable discomfort.

The effect of the ankylosis of individual toes on the usefulness of the foot depends, among other things, on the position of the affected toe. The extent to which the patient may be disabled has already been discussed.

The stiffness and deformity of the toes after severe



Fig. 142.

comminuted fractures may so lessen the usefulness of the foot as to render their amputation or disarticulation desirable. Even after such operations, especially if parts of the corresponding metatarsal bone have to be sacrificed, there may remain serious interference with function.

Case of fracture of the distal phalanx of the great toe. (Fig. 142, p. 531.)

A workman, forty-seven years of age, sustained the foregoing lesion in September, 1898, when a heavy stone fell on and crushed his great right toe. The blood extravasation was opened by the surgeon who dressed the foot. The patient lay in bed for two weeks and began to work at the end of the third week. He made a perfect recovery.

Case of fracture of the distal phalanx of the great toe which was crushed by an iron rail. (Fig. 143, p. 533.)

The accompanying skiagraph (Fig. 143) shows the line of fracture on the tip of the great toe very distinctly. The treatment in this case consisted of compresses and rest in bed; the patient began to walk two weeks after the accident, and resumed work in four weeks. The skiagraph was taken at the latter time.

The scar resulting from the amputation of the great toe and a portion of the first metatarsal bone is sensitive to pressure, and interferes with walking if it extends out on the under surface of the ball of the great toe; hence the patient steps on the outer part of the sole. He has, in addition, lost the support of the head of the metatarsal bone. Disarticulation of the toe at the metatarsophalangeal joint has an equally unfavorable effect if the scar is so placed as to interfere with walking. Even when the latter is not exposed to pressure, it may give trouble for some time by forming adhesions with the bone. Many cases of disarticulation at this joint, however, have a very favorable functional result.

The opposite effect, as to position of the foot, is seen after removal of the fifth toe or of the fourth and fifth toes, together with a portion of their metatarsal bones, the patient using the inner border of the foot in walking, both on account of the location of the scar and because the normal outer support of the foot is lacking. These disadvantages are not found after disarticulation of the fifth



Fig. 143.

toe or of the fourth and fifth toes at the metatarsophalangeal joints.

The retraction of the cicatrix after amputation of the second toe and a portion of the second metatarsal bone may go so far as to cause the third toe to override the great toe.

The insurance allowance for loss of the great toe is rated at from 10% to 15%. An unfavorable scar and inability to walk on the inner border of the foot further increase the incapacity, and raise the rate accordingly. The loss of each of the other toes is compensated for by 5% ; here, too, a higher rate is allowed in unfavorable cases.

Amputation of all the toes may, if the scar is favorably located, leave a comparatively useful member, the patient being able to perform heavy work. If so, an insurance allowance of from 20% to 25% is sufficient.

The usefulness of the foot is much more impaired by the loss of all the metatarsal bones (Lisfranc's operation). For workmen who are obliged to be on their feet, and possibly to carry heavy loads, from $33\frac{1}{3}\%$ to 40% should certainly be the minimum rate. In a few cases personally known to me the patient has received 60% for several years.

After Chopart's operation, and to a still greater degree after Pirogoff's operation, the patient is quite unfitted for heavy work or to carry weights. For these cases an insurance allowance of 50% is indicated.

It should be borne in mind that steadiness in walking and standing depends on the size of the surface of the foot which comes in contact with the ground. When this is diminished by contracted scars, by atrophy of the muscles and the plantar fat, or by deformity of any kind, the gait suffers a proportionate loss of steadiness.

Traumatic Tuberculosis of the Foot.

Tuberculous foci are frequently developed in the bones of the tarsus or in the ankle-joint, especially as a result of slight injuries, such as contusions or sprains. Many such instances have been reported. I have cited a number in the foregoing pages, accompanying some of them with illustrations.

Rate of Indemnity for Deformities of the Foot.

A rate of $33\frac{1}{3}\%$ is ample for an absolutely stiff ankle, unless talipes valgus or varus exists at the same time, when it may need to be higher.

Among the paralyses of the foot and leg with which we have to deal the paralysis of the muscles supplied by the peroneal nerve deserves special consideration. This is most apt to occur in alcoholic subjects, but is not confined to them. The symptoms are often quite severe.

In one case coming under my observation the muscles in question were completely paralyzed, and the patient was obliged to wear a shoe with side braces in order to walk at all. He received 40% insurance allowance. In another case the patient, who was a heavy drinker, suffered from a complete sensory paralysis of the area supplied by the peroneal nerve for two days after every spree. Deep pin-pricks caused no pain. The anesthesia was followed by extreme hyperesthesia.

Paralyses of habit are sometimes observed. A patient, for instance, walks on the outer border of the foot because of some painful condition of the inner portion of the sole; the tibialis anticus becomes contracted, which finally leads to spastic paralysis of the antagonists, and to permanent deformity of the foot.

In making an examination of the lower extremities it is essential to compare the two sides—first with the patient lying on the back, then standing, with the feet placed parallel. The examination-stool which I have designed will be found very serviceable. The gait should

be tested, and the condition of the sole of the foot should be ascertained ; finally, it is necessary to determine the strength of the injured foot or leg, both in itself and in comparison with that of the other side.

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